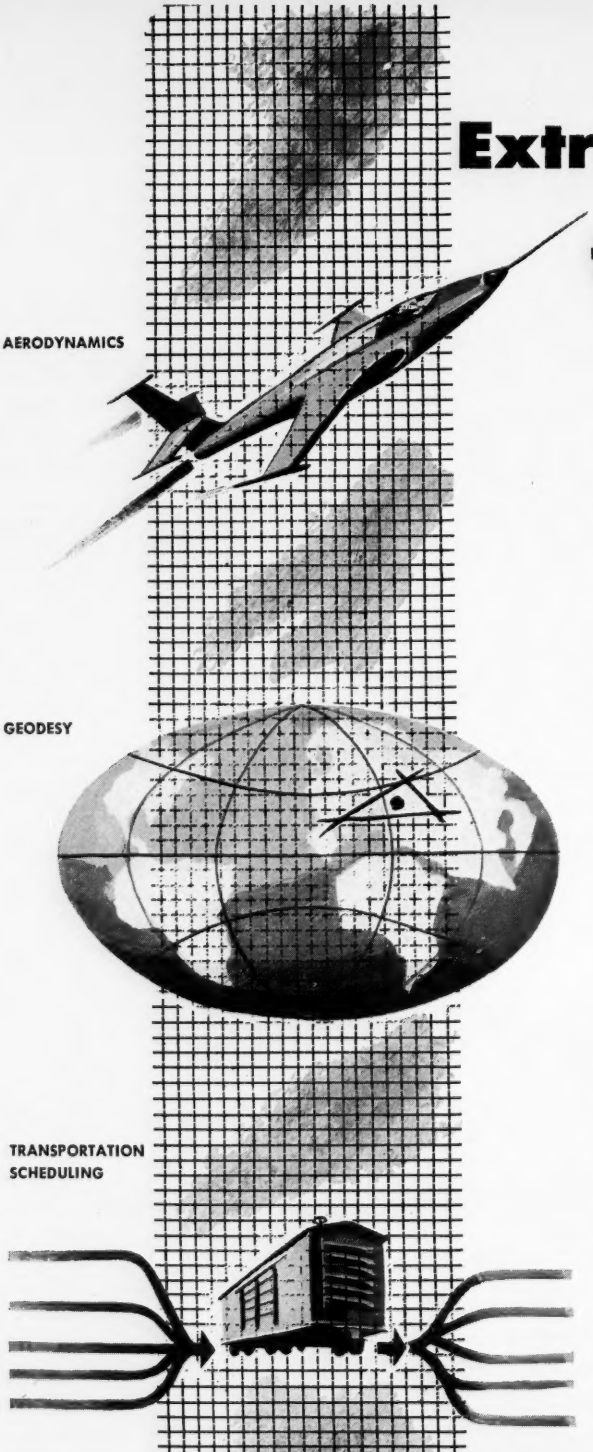
COMPUTERS AND AUTOMATION

YBERNETICS · ROBOTS · AUTOMATIC CONTROL

Extra Core Storage for IBM 704



- **increases IBM 704 capacity to the binary equivalent of 327,680 decimal digits!**
- **gives high-speed random access to any memory address!**

NOW... with this *expandable* memory system, mathematical models can be expanded to include phenomena heretofore beyond the capacity of any computer!

NOW... researchers can have random access to all elements of a matrix of order greater than 175 in only 12 microseconds!

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NOW... an arbitrary matrix of order greater than 125—with every element expressed to a precision greater than that obtained by using *20* decimal digits—can be inverted without aid of auxiliary storage.

This new *expandable* memory system can be considered as three modular units. Models I and II of the familiar IBM 737 Memory store respectively 4,096 and 8,192 ten-digit words. The IBM 738, with its 32,768 ten-digit words of random access core storage, replaces the other two units.

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COMPUTERS AND AUTOMATION

CYBERNET CS • ROBOTS • AUTOMATIC CONTROL

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THE EDITOR'S NOTES

NAMES AND ADDRESSES OF COMPUTER PEOPLE

We were glad to make available to the Joint Computer Conference at no cost the names and addresses on punch cards of some 7500 computer people; and they were used. This was for the purpose of their mailing of announcements for the meeting of the Joint Computer Conference in Boston in November. (See elsewhere in this issue for details of the meeting.)

We are eager to do what we can to keep a complete and up-to-date punch card file of persons interested in computers. This is the basis for the Who's Who we publish; and can be the basis for mailings of meeting announcements by such organizations as the Joint Computer Conference. The names and addresses in this file however are not used for advertising purposes unless they are released.

CHANGE OF SUBSCRIPTION RATES

Effective Dec. 1, the subscription rate for "Computers and Automation" will change from $4.50 a year to $5.50 a year. The rate of $4.50 a year has applied since Vol. 1 no. 4, October, 1952, when our frequency was quarterly and the size of issue was about 32 pages. We now publish monthly, with the size of issue about 48 pages, and one issue (The Computer Directory Issue, June) considerably larger (this year 164 pages).

In October 1952, the rate was about 128 pages for $4.50. The price therefore was about 3½ cents a page. In the twelve months ending Oct., 1955, we published 702 pages. 700 pages for $5.50 is just about 3/4 of a cent a page.

As before, new bulk subscription rates, applying to two or more subscriptions coming in together will apply, making the basic subscription rate of $5.50 considerably lower in such cases.

CHANGE OF ADVERTISING RATES

Effective Dec. 1 for insertions under orders received after Dec. 1, and effective Feb. 1 for insertions under orders received prior to Dec.1, the advertising rates for "Computers and Automation" will change, increasing about 10%. The half page rate for example will increase from $90 to $97.

We now have about 1900 subscribers as compared with about 1300 when the old rates went into effect on Jan. 1. Thus the cost per subscriber changes from about 6.9 cents to about 5.1 cents. If nonsubscribing readers were included, the cost we believe would be cut more than half, to less than 2½ cents. This is considerably less than the cost of mailings.

Forum

THIRD CONFERENCE ON HIGH-SPEED COMPUTERS,
LOUISANA STATE UNIVERSITY,
BATON ROUGE, LA., FEB. 15-17, 1956

Charles W. Barnett
Thomas Boyd Hall
Louisana State University
Baton Rouge 3, La.

The 1956 Conference on High-Speed Computers will be held at Louisiana State University, Baton Rouge, Louisiana, from February 15 through February 17, 1956. This conference is open to businessmen, office managers, accountants, engineers, mathematicians, chemists, physicists, economists, statisticians and other potential users from all sections of the country. Topics scheduled for discussion by nationally recognized speakers include office procedures, statistical operations and numerical methods designed for the adaptation of problems to machine solution. Several manufacturers of computing equipment will be represented through exhibits or demonstrations of computers in operation.

Inquiries concerning the conference may be directed to me or to:

Dr. J. W. Brouillette, Director
General Extension Division
Louisiana State University
Baton Rouge 3, La.

INDEX OF NOTICES

Address Changes: If your address changes, please notify us giving both old and new address, and allow three weeks for the change.

MISSILE SYSTEMS MATHEMATICS

The technology of guided missiles is literally a new domain. No field of science offers greater scope for creative achievement.
The increasingly complex problems associated with missile systems research and development are creating new positions in the following areas for Mathematicians possessing exceptional ability:

- Guided Missile Systems
- Nuclear Physics
- Computer Research and Development
- Engineering Management Problems

Inquiries are invited from those interested in personal development in an appropriate scientific environment.

AMERICAN MATHEMATICAL SOCIETY MEETING

Los Angeles, Nov. 12
Houston, Dec. 27-30

Senior members of our technical staff will be available for consultation at both meetings. If you plan to attend these meetings, please contact our research and engineering staff for interview.

Lockheed

MISSILE SYSTEMS DIVISION

research and engineering staff

LOCKHEED AIRCRAFT CORPORATION

VAN NUYS, CALIFORNIA

AUTOMATIC ANSWERING OF INQUIRIES

L. E. GRIFFITH
The Hospital Care Association, Inc.
(The Blue Cross Plan)
Home Office, Durham, N. C.

Automatic devices are in common use in many fields of office activity and while naturally they often take away the sense of personal treatment normally given in day-to-day dealings between people, nevertheless, they assist materially in the reduction in the labor forces required to operate a number of enterprises. So far as offices are concerned, a number of devices of a mechanical type are used to improve the quality of work, to speed up production, and to insure that the most economical method is adopted. In recent years this move towards office automation using highly developed mechanized methods has gained considerable impetus. Modern management does not think today in terms of whether or not a piece of paper should be handled twice in a procedure; management now asks first of all, whether a piece of paper is necessary and if it is found necessary, then asks the question "how, when and where" will this machine or that machine process this piece of data. Integrated data processing through recent electronic developments is a reality and no longer a matter of speculation.

A field which appears to have been almost ignored is that of applying the recording and speaking type of device to the purpose of answering questions, and inquiries, and giving instructions, with particular application to those office agencies primarily concerned with this kind of work. At the present time, there is no automatic way for dealing orally with standard type inquiries that require more than a few words to complete the answer and often a complete explanation, except in a few areas like the automatic telephone reporting of weather forecasts. Why should not a recording-type instrument, together with a speaking-type instrument be used for this purpose? For example, everyone knows how to use a juke box; it is quite a simple matter to arrange for a juke box to carry records answering various inquiries about a business and to be available to inquirers without the presence of actual personnel. The juke box could give appropriate instructions on how to complete forms and how to carry out a variety of actions. In a similar way, a telephone linkup could provide answers to inquiries received over the telephone. A great many people find it easier to understand oral explanations than written ones; and this is natural because our first language is the spoken language and not written language.

This suggestion may appear rather radical. But we have become convinced that a scientific study of several types of office inquiry-answering would permit automatic machines to answer questions and instruct, as required, the person using the machine.

The arrangement described in further detail below would be suitable for:

(1) All types of offices where the presence of staff on a permanent basis is a matter of difficulty or where a staff cannot economically be employed.

(2) Enrollment Campaign Bureaus. For example, if an insurance company were to carry out an enrollment campaign, it might be possible to use a number of automatic enrolling units instead of actual agents.

(3) Certain types of investigations are suitable to machine inquiry. For example, Gallup Poll type investigations where a number of people are to be questioned about a number of things. It might be that the machine interviewer would be better than the human interviewer in a case where the human interviewer can, by any slight departure from the standard pattern of questions or by factors in his personality, affect the nature and validity of the answers of the respondents.

(4) City Information Bureau. It would be possible, with machines of this type, to have information bureaus in various parts of the town, giving brief descriptions of places of interest, ways of getting to them, and the like. This would, of course, not replace fully the normal type of printed material already available, although such machines could be used to cut the volume of the material now so prolifically disbursed in this way.

(5) Post Office Bureau. For the answering of Income Tax inquiries, questions about postal regulations, and many other matters handled by Post Offices.

(6) Recruiting Centers. Here filling out forms is very much a part of the recruiting procedure. Often we might expect that the new recruit or draftee would prefer a friendly recorded introduction to his new life from a top ranking military man, rather than the foreboding impression normally created by the first top ser-

geant he meets. There are, of course, many other aspects of office work, training work, and the like which lend themselves to the use of automatic machines of the type described here. Application of inquiry-answering machines would result in a large saving of manpower at present immobilized by answering other peoples' questions.

(7) Hotels. Apart from the use described generally above, a particular use in hotels and similar places would be its use to give information as to the entertainment to be obtained in the city, with perhaps brief descriptions as to plot content in the case of plays and films, and reports of the opinions of professional critics on the entertainment. At the same time, the price range (for instance, in covering "night spots") could be mentioned.

(8) Translations. In hotels in cosmopolitan areas, an extension of the device could be used so that questions put to the machine would be answered in any one of several languages as elected. That is, the question panel would cover certain situations in a number of languages. By operating the language button for say French, the answer to the question would then be given orally in French.

This application (The Automatic Interpreter) is, of course, not limited to the hotel field. It would be useful at transportation centers, on ships, and in fact wherever the cosmopolitan nature of the population using the machine would make advantageous the inclusion of translations in it.

(9) Personnel Offices. Personnel offices by the nature of their work very frequently require inquirers to fill in forms prior to interview; more often than not, sections of the forms require explanation. By the machine approach, properly worded and recorded to take away a person's possible nervousness about the impending interview, the forms would be more accurately completed and the time of the eventual interviewer saved. This would also allow the interviewer to concentrate on his real job, which is interviewing, and not, as is often the present case, the supervision of the form filling activities to the detriment of the interviewing activities.

(10) Factories. The equipment described also has its place in the factory for instructing, questioning, and answering inquiries.

(11) Airports, Train and Bus Terminals. Certain types of questions, inquiries and instructions could be handled automatically at transportation centers.

(12) Stores. The automatic information approach has wide range of application in stores and the like, and still would not remove the personal touch often necessary in selling and buying activities.

(13) Hospitals. Among other possible uses in hospitals would be its use as a direction instructor -- this is particularly so in large hospitals. In practically all large hospitals and other buildings, a lot of time is wasted by people working in them in directing or redirecting visitors to the offices or rooms they are trying to get to.

Figure 1 represents a model layout for one automatic inquiry-answering unit for our own possible use. Many variations of this unit would, of course, be used depending on the type of installation. Even for our use, the device has various alternative designs, and the figure incorporates only some of the features which the final designs include.

(1) Panel of buttons with corresponding question plates. The buttons in this panel operate the sound-producing mechanism housed in the stand upon which the button panel rests.

(2) The unit housing, the amplifier, speaker and sound-producing apparatus (record or tape type). This piece of furniture in certain alternative designs contains in addition a form-dispensing device, permitting only one form from any one compartment to be ejected at one time. If also contains a mail chute, and writing material (pen, pencil, etc.) section. It would also contain an information panel on how the machine should be used.

(3) The desk and chair, including a rack of stationery, writing material (pen, pencil, etc.), and mail chute.

(4) A panel of instructions, on how to operate the machine. It may be hung on the wall or attached to the machine. It would normally be the first thing that a user would see on entrance to the office. In some cases, the instructions would be in more than one language.

(5) Clock, and automatic date-changing calendar.

Preferably, the forms would be accompanied by a form-dispensing device by which only one copy of each form could be obtained at one time. All forms should be designed to assist processing at later stages. Ideally, the customer or inquirer would thus himself create the basic record concerning the transaction in a style best suited to efficient handling later.

The fields in which an automatic inquiry answerer in one or more of its aspects may be

used appear to be nearly as diversified as human activity itself. The list given above is not exhaustive. It may be argued that the machine approach takes away a valuable personal touch in dealings between people. This is not necessarily true, however, because the personal touch may cause as much friction as harmony, and because many people are nervous in their contacts with strangers. Also, the personal touch often leads to incomplete, non-authoritative replies to inquiries, and sometimes to rude replies. The machine approach can be friendly, as well as expert, particularly if its purpose (the lower cost) of this approach is explained to the user and also if the recorded voices and personalities are selected well. One record or tape recording could be used to deal with all introductory material of this kind, including some remarks on how to use successfully the remaining devices. In this case, all users would be requested to operate this button before going on to their particular question or questions. The mechanical approach does not prohibit the use of humor in the recordings. Friendly voices remain friendly whether they are recorded or not. (An extension of the mechanical approach might include projection of a film of the person talking synchronized to the words spoken.)

It may be argued that illiterate people would be unable to use these machines. But illiterates would very likely understand "X" and could be told to press the "X" button; whereas the instrument panel would contain a notice to the effect that literate persons should <u>not</u> press the "X" button.

On broad grounds, the development of automatic inquiry-answering and instructing devices would prove invaluable, since economy of manpower is becoming more important all the time.

- END -

Forum

UNIVERSITY OF MICHIGAN SUMMER SESSION NOTES ON COMPUTERS AND DATA PROCESSORS

John W. Carr, Assistant Professor of Mathematics, and Norman R. Scott, Associate Professor of Electrical Engineering
University of Michigan
Ann Arbor, Michigan

The Notes for the third Annual Special Summer Session on Digital Computers and Data Processors will be completely printed by November 1.

About 150 pages have been included of verbatim stenotypist transcription of "Reports from the Users" from seventeen different users of the following types of equipments: Univac, Univac Scientific (ERA-1103); IBM types 650, 701, 702, 704, 705; Electro Data, CRC-102A, Oracle, SEAC, Whirlwind, Illiac, MIDAC, and "Computers in Great Britain and Australia".

These notes have developed as a result of three years of teaching in regular graduate classes as well as in the Summer Conference and we believe contain a wealth of information on computer usage and design. Since we are now using the notes in our regular winter classes, we decided that they should also be made available to the computer field in general. They may be ordered from Special Summer Conferences, College of Engineering, University of Michigan, for $10.00 (the cost of printing.)

A partial list of the lecturers at the summer session follows:

C. W. Adams, Westinghouse & MIT
Samuel Alexander, National Bureau of Standards
Walter F. Bauer, Ramo-Wooldridge Corporation
R. W. Bemer, Lockheed Missiles Division
Arthur W. Burks, University of Michigan
John W. Carr, University of Michigan
Richard Clippinger, Datamatic Corporation
B. C. Connelly, Air Material Command
James Cranwill, Franklin Life Insurance Co.
John DeTurk, Hycon Eastern, Inc.
Paul S. Dwyer, University of Michigan
Jean H. Felker, Bell Laboratories
Wallace W. Gardner, University of Michigan
Roy Goldfinger, IBM Corporation
H. H. Goode, University of Michigan
H. R. J. Grosch, General Electric Co.
Rudolph Haberman, General Electric Co.
David S. Hoffman, Gulf Research & Development
Grace Murray Hopper, Sperry-Rand
Alton S. Householder, Oak Ridge National Labs
George Kalb, Burroughs Corp.
Paul Knaplund, IBM Corporation
Harold Kuhn, Bryn Mawr College
E. P. Little, Wayne University
Wesley Melahn, Rand Corporation
W. Michael, Bendix Computer Div.
Herbert F. Mitchell, Sperry-Rand
John Allen Ovenstone, Weapons Research Est., Aust.
William Papian, MIT
Alan J. Perlis, Purdue Univ.
Wesley Peterson, IBM Corporation
James Robertson, U. of Illinois
Norman R. Scott, University of Michigan
Daniel B. Suits, University of Michigan
Gordon C. Stubbs, Haskins & Sells
Harrison Tellier, General Electric Co.
Robert M. Thrall, University of Michigan
Glenn E. White, Chrysler Corp.
W. Wright, Haskins & Sells
Irving Zillers, IBM Corporation

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(continued on page 16)

FOUND — A "LOST" MOON

Dr. Paul Herget
University of Cincinnati Observatory
Cincinnati, Ohio

(Reprinted by permission from Remington Rand's "Systems Magazine", July-August 1955)

The day of interplanetary rocket travel may not be far around the corner. When that day comes, rocketeers will find that their routes may be safely charted. An accurate course among the minor planets and satellites will be possible, for by that time their paths should be well defined. Whether the satellites are to be avoided or reached at some rendezvous in space, their positions will be well known.

All this important "travel" information covering the minor planets or asteroids will be available because the fantastic speed and pin-point accuracy of electronic computing has made it possible to eliminate the tedious time-consuming manual computations hitherto unavoidable in obtaining vital astronomical data.

The University of Cincinnati Observatory has a special responsibility to the International Astronomical Union for the calculation of the movements of more than 1,600 minor planets in their orbits around the Sun. These objects play an essential role in such astronomical problems as practical navigation on the one hand, and theories of the origin of the solar system on the other.

In the past there has been a tremendous amount of time-consuming work, usually performed with tables of logarithms or desk-type calculators, involved in the problem of calculating the past, present, and future positions of the minor planets. Historically, the astronomers have been the leaders in scientific computations, and it was only natural that we should want to make the most of the advantages afforded by such powerful electronic computing equipment as the Univac.

It is a pleasure to acknowledge the enthusiastic cooperation we received when we presented this problem to Dr. John W. Mauchly, Director of Scientific Studies at Remington Rand and co-inventor of the Univac. He assigned a programmer to collaborate with us in preparing the calculations for Univac operation, and thus began a thrilling experience which can hardly be appreciated by anyone who has not seen many long hours of his work reduced to seconds or minutes.

Although our ultimate problem is to keep track of all the 1,600 minor planets, we decided to test this application of Univac techniques with a smaller pilot model operation on the outer moons of Jupiter — numbers VIII, IX, XI, and XII.

Jupiter, the largest planet in the solar system, is attended by 12 satellites or lesser moons. The first four -- Io, Europa, Ganymede and Callisto (the only ones with names) --were the first objects discovered by Galileo in 1610 when he invented the telescope. They have served to bring about the discovery of the motion of light and the determination of its velocity, as well as an earlier method for determining longitudes.

Not until 1892 was another moon discovered, this one very tiny and very close to Jupiter. Since 1906 seven other very faint ones have been detected photographically, some at the Lick Observatory, one at Greenwich, and others at Mt. Wilson.

Dr. S. B. Nicholson is the discoverer of the last four, the most recent being in 1951. Last winter he wanted to photograph Jupiter VIII, because it had been unobserved since 1941. It was not that Jupiter VIII had wandered away from its orbit about the planet Jupiter, but precise calculations as to its present position were unavailable. The last known computations had been worked out by Dr. H. R. J. Grosch in 1938.

The numerical data from this work, where Dr. Grosch had left off his computations in 1941, and the necessary program for the calculations were fed into Univac. It required about 20 minutes of Univac time to calculate the path of the satellite Jupiter VIII up to the year 1980. Seven additional calculations were carried out at the same time, requiring a total of about 2½ hours of Univac time, so that it will be possible to take into account any future corrections which the basic computations may require during the next quarter of a century.

The calculated predictions of the positions of Jupiter VIII in 1955 were sent to Dr. Nicholson and, using the 100-inch Mt. Wilson telescope, he located the faint image of the eighth Jovian satellite within one minute of arc of the Univac computations.

This is about the size of a penny when viewed from a distance of 200 feet. The planet Jupiter is 500 million miles away from the

Earth, and Jupiter VIII is 15 million miles away from the planet. The light from this moon is so faint that it would have to shine 100,000 times brighter in order to become just barely visible to the unaided eye; in fact, it is invisible to anything but the most powerful telescopes.

Furthermore, the orbits of these moons are neither circles nor any simple form of ellipse. At certain times the gravitational attraction of the Sun on the satellite exceeds the gravitational attraction of Jupiter on the satellite, even though it is supposed to be one of the moons of Jupiter. This means that the moon follows an extremely uneven path, always keeping an even balance between the two principal attractions to which it is subjected.

The only effective method known for computing such a complicated path is the one which was used on the Univac. Formerly this had to be carried out more laboriously by hand, deriving the changing position of the satellite for ten-day periods as it moves around Jupiter in a period of two years. A hand calculation requires from 10 to 15 minutes to advance the computations one 10-day period; Univac accomplished the same amount of work in 5/6th of a second.

16 Million Operations

In all, dealing with the four outer moons of Jupiter and taking into account the total of 32 variables to be computed for a period from 1940 to 1980, more than 16,000,000 operations were performed on the Univac. For such work to be done by hand would have taken about five man-years.

This project has not only permitted the successful recovery of the eighth satellite of Jupiter after a period of 14 years, but it also serves as a proving ground for the much larger operation of computing the present and future orbits of the 1,600 minor planets. With such powerful computing equipment as Univac, it is estimated that it will take only about 500 hours to complete the necessary calculations for establishing the reliable orbits of all of the minor planets on the basis of past observations, and their motion in orbits around the Sun under the influence of the law of gravitation, and to make reliable predictions for a quarter of a century into the future.

Push-button astronomy is here. Univac's abilities and capabilities to overcome the time-consuming factors which astronomical calculations entail, remove the limits from astronomers in their search of the skies and solutions to other problems of the universe.

- END -

Forum

EASTERN JOINT COMPUTER CONFERENCE

Hotel Statler, Boston, Mass.,
November 7, 8, 9, 1955 -- Advance Program

Monday, November 7

Morning -- General Session

Chairman: Irven Travis, Vice-President, Burroughs Corporation

Keynote Speaker: J. G. Brainerd, Director, Moore School of Electrical Engineering, University of Pennsylvania

Address: John S. Coleman, President, Burroughs Corporation

Afternoon — The Role of Computers in Business

Computers in Basic Business Applications
F. J. Porter, Commercial Manager, Machine Procedures and Machine Operations Bureau, Consolidated Edison Company of New York

This paper will discuss some of the problems encountered in applying present day computers to basic business operations such as payroll, billing, and inventory. It will indicate areas which need to be considered by the engineer or designer who wishes to make tomorrow's computer more useful in these fields. The subject will be treated solely from the viewpoint of the businessman user.

Operations Control with an Electronic Computer
Benjamin F. Butler, Manager, Operations Research Study, Hanford Atomic Products Operation, General Electric Company

Relationship between planning decision rules, measurements, and analysis in operations control. How automation is attained. Opportunities for electronic computers in operations control. Experience in operations control with electronic computers.

Evening — Cocktail Party and Reception

Tuesday, November 8

Morning -- Cards, Tapes and Other Records in Electronic Accounting Systems

Manual Use of Automatic Records
Anthony Oettinger, Instructor in Applied Mathematics, Harvard University Computation Laboratory

Records that are to be processed automatically necessarily must be stored in media accessible to a machine and in codes suitable for machine interpretation. Consequently, such records may not be readily accessible to the unaided human clerk. Steps that may be taken to provide adequate facilities for occasional manual interrogation and processing of automatic records are suggested and examined critically.

Evaluation of Sorting Methods
James C. Hosken, A. D. Little, Inc.

Sorting is defined as rearranging randomly ordered information into numerical or alphabetic order. Reasons for sorting and possible ways to avoid sorting are enumerated. The theory of common sorting methods is described. Equipment required and results obtained in specific cases are outlined.

Document Processing
R. H. Gregory, Asst. Professor of Accounting, School of Industrial Management, Massachusetts Institute of Technology

Economies in document processing are likely to arise from document conversion into a form suitable for processing as a by-product of other operations, reduced manual-machine handling, or even elimination of the document itself. Sampling and approximate results may give workable precision at substantial net savings. Achieving this will require re-examination of documentation, information origination and flow, input and output techniques, centralization of processing, and precision of results.

Afternoon — Trends in System Design

The Computer and its Peripheral Equipment
N. Rochester, Development Engineer, Engineering Laboratories, International Business Machines Corp.

A large scale computer is only part of a system for handling information. The peripheral equipment which furnishes data, displays or prints results, and retains intermediate results or reference data is often more complex than the computer and often provides the bottleneck which limits system performance. An important recent trend in scientific, commercial, and real time control applications of computers has been increased attention to peripheral equipment, and improved communication between man and machine.

Computers with Remote Data Input
Edward L. Fitzgerald, Service Engineer, E. I. du Pont deNemours Company

Remote computer input facilities will influence the basic approach to centralized data processing as computer applications expand toward their basic source of documents. Conventional concepts of data accuracy requirements may be modified by the use of statistical techniques in the final processing. The utilization of a central computer by remote locations for producing special reports will be influenced more by automatic programming techniques than by input hardware. The basic computer requirement of uniform input data format must be related to a number of different transmission systems and originating points. Recent trends in data processing costs for

large scale computers indicate a pending radical departure from existing methods of format control on input equipment.

Developments in Programming Research
Charles W. Adams, Consultant to Director of Office Methods and Procedures, Westinghouse Electric Corp.; Assistant Professor of Digital Computation, on leave from Massachusetts Institute of Technology

Continually increasing use of stored-program digital computers places increasing emphasis on the time and cost of preparing the programs in the first place. Automatic coding techniques aim to use the computers themselves to make coding easier to learn, to make coded programs easier to write, and to make mistakes in coding easier to find, easier to correct, and easier to avoid entirely. The extensive development of these techniques for scientific and engineering application will be summarized as a background for a discussion of the somewhat different requirements of business data processing, for which the development of automatic coding techniques has but recently commenced.

Storage and Retrieval of Information
Louis N. Ridenour, Director of Program Development, Missile Systems Division, Lockheed Aircraft Corp.

Memory-system design is central to the design of information-processing equipment. Three general memory requirements are distinguished:

(a) The high-speed inner memory of an electronic machine.
(b) The auxiliary memory often used to extend the storage capacity of the inner memory and to serve as an input-output buffer.
(c) A large-capacity ($>10^8$ bits) machine-readable file.

Memory devices meeting satisfactorily the requirements of (a) and (b) are now available in a good state of development. Requirement (c) remains a challenge to the ingenuity of the designer. The elements of a possible solution are discussed.

Wednesday, November 9

Morning — Communication and Compatibility Among Electronic Computers in Busines and Industrial Use

The Role of Communications Networks in Digital Data Systems
R. C. Matlack, Special Systems Engineer, Bell Telephone Laboratories

Communications have played an important role in linking together teletypewriters in manual and automatically switched networks. There is a rapidly growing need for higher speed communications to transmit digital data from remote to centralized locations. New engineering and maintenance approaches are necessary to take advantage of the existing widespread voice communication facilities. Since this plant has been primarily designed for voice transmission, new techniques are desirable to insure reliable high speed data transmission and switching. This would be facilitated by use of a universal language and standardized speeds of transmission. The speaker will discuss these problems as viewed by a communications supplier and will present his views on future development.

Standardization of Computer Intercommunication
H. R. J. Grosch, Manager, Investigations, Aircraft Gas Turbine Dept., General Electric Company

Statements from Manufacturers on Standardization of Magnetic Tape Records

The increasing use and general acceptance of magnetic tape records in business and industry have created problems of standardization and interchangeability of these records. From the users' point of view the ability to record information on tape from one computer and read it on another is obviously desirable.

Manufacturers of computing equipment and other interested parties will be called upon to discuss some of the technical problems involved in achieving interchangeability and to comment on their interest in participating in an industry-wide standardization program.

Luncheon Meeting

Chairman: J. H. Felker, Radio Development Engineer, Bell Telephone Laboratories

Implementing an Industry-wide Standardization Program
W. R. G. Baker, Vice-President, General Electric Company

Conference Summary
Jay Forrester, Director, Digital Computation Laboratory, Massachusetts Institute of Technology

- END -

MISTER ANDREW LLOYD

RICHARD W. WALLACE
Akron, Ohio

They hated his guts at International Atomics for the major reason that he was always right and they were always wrong. Furthermore, his ability to make quick, on-the-spot decisions was uncanny. The man, Mr. Andrew Lloyd, was absolutely tireless. He could remain in conferences for long hours, far into the night. He led a model life. No smoking. No drinking. No women. As a matter of fact, he was a bachelor.

The manager of International Atomics' Export Division, Mr. Gerald P. Alexander, for one, learned how cold and ruthless Mr. Lloyd and his decisions could be. For the past three months, Alexander's decisions hadn't always turned out for the best of International's interests. Several fine markets for radioactive waste byproducts in Argentina and South Africa had gone to a foreign competitor by default.

Alexander's position within the company was sufficiently high that he tried to save his neck by calling in a plushy industrial management firm to make a special survey at a fancy fee. The idea of the survey was that they would find that a reorganization of the Export Division was necessary. This would give Alexander an opportunity to fire a number of people to make everything "look good". After the whitewash he figured he'd be on top again, completely absolved.

Matters did not work out that way, however. At a meeting of the Executive Committee, over which Andrew Lloyd presided, Alexander submitted a voluminous report on the export situation for IA. Lloyd, nobody's fool, had requested this report; Alexander, no novice at saving his corporate skin, had made the report exceedingly complex to hide and disguise his blunders. This was to be his interim measure until the management firm had completed their survey and he could fire half of his department.

At the meeting Andrew Lloyd deftly fingered his way through the 500-page tome. His face was cold and expressionless. Alexander smiled cunningly at Neils Larson, seated next to him. Larson was his best friend and head of U. S. sales. Between them they now had surely found a way to trip up the infallible Mr. Andrew Lloyd. They had done it with a report so long and complex that it gave them time to complete their colossal whitewash.

Lloyd was methodically turning page after page. He had leafed through about two hundred and some odd pages that way, scanning them rapidly, while everyone silently sweated it out. This was unusual; one didn't give this much attention to reports submitted during a meeting. This was something he was supposed to take into his office and never find the time to read. Alexander, though, was convinced he had the bull by the tail at last. He lit a cigarette, inhaled deeply, and then exhaled noisily and luxuriously. He smoothed back his white hair and winked at Larson.

Lloyd's cold, steely voice cut through the silence.

"Out with the cigarette, Mr. Alexander. You know I do not permit anyone to smoke at meetings of this committee, or at any meetings over which I preside."

Alexander ground out the cigarette grudgingly.

"I'm sorry, Andrew. I thought you were reading my report-"

Lloyd looked up from the report, gave Alexander a cold stare that chilled him to the marrow, and stopped reading.

"And you also know that I am never addressed my my first name. Yes, I have been reading the report. In fact, I've read all I need to read. I have digested all of the facts, and the logic adds up totally to your discredit. As a result of your obvious confession of ineptness contained in this report, I would like your resignation by three this afternoon. You have two hours to prepare it."

"But...but..." sputtered Alexander.

"That's sufficient. You may be excused from the meeting."

It wasn't very long before the fireworks in the meeting got around International's swanky world headquarters. Mr. Lloyd was looked on with an even higher degree of fear than ever before.

Lloyd had been with the company for about a year. Not much had been known of his career prior to his coming with IA. His arrival was most simple. The Chairman of the Board of

Directors announced that Mr. Andrew Lloyd was to head the company as President and that he had the full backing of the Board of Directors.

Efforts on the part of astute executives of IA to learn something about Lloyd's background were entirely unproductive. One worried executive even went so far as to hire an expensive firm of private investigators to probe into his past. But it seemed that he had no vices, no weaknesses, and seemingly no past.

In appearances he was a young man, not in the immature sense, but in the young executive sense. He was about six feet tall, broad-shouldered, affected a crew cut, and wore finely tailored suits. His eye had a steely glint and he was able to sum up the logic of the most complex management decision problems in a very few minutes. Many of these problems were of such an order of magnitude that only huge electronic data processing machines could hope to cope with them adequately.

As for Alexander, it is needless to say that he left the meeting in a daze and cold sweat as he headed back to his office. He simply couldn't believe that a twenty-five year career with a company could be wiped out in as many seconds by a ruthless young man who was able to assimilate a 500-page report in a few minutes. He winced when he thought of having to give up the new retreat he had bought in Canada for his retirement days. He was ruined. He knew that a man at his age couldn't find another position like the one he had lost. In his office he wondered about many things; his pension, his future, how A. Lloyd could seem to read a report so fast. And he raged.

He tried to think things out logically, but efforts at thinking things out gave way to cold, unreasoning fear and rage. It was three o'clock. His secretary had placed the typed resignation on his desk. He picked it up and reached in his desk drawer for something else he wanted. It gave him a comfortable feeling to have the gun in his pocket. He walked slowly toward Lloyd's office. He would kill him as he read the resignation.

But he found he was not to be allowed to enter the office, for an attendant stopped him at the door.

"Do you have your resignation, Mr. Alexander?"

"Yes...but, I want to take it in. I have something to say..."

"Mr. Lloyd gave orders. He's not to be disturbed. The resignation please?"

Alexander gave it to him. The attendant opened the heavy door and closed it behind him. A minute later, the door opened and the attendant started out. Alexander could see Lloyd seated at his desk. Hatred of the man and fury again boiled up inside of him. He knocked the attendant to one side, rushed towards Lloyd, and fired the gun at him. His victim slumped over on his desk. Alexander glanced at the crumpled figure, then opened the window behind the desk, and hurled himself out.

The office staff gathered quickly into a buzzing throng outside of Lloyd's office door. Larson arrived running, pushed his way through the small crowd and into the office, followed almost at once by Dr. Whitby the company's physician who had been hastily summoned from the company's medical dispensary on the floor below.

Dr. Whitby immediately examined Lloyd, while Larson went to the window and stared at the crowds gathered on the street, thirty-five floors below. The doctor whistled softly to himself. Larson came over beside him. When he had looked at what the doctor showed him, he whistled even a little louder. Just then, V. Q. Maltby, the General Manager, strode in briskly with a 'what-the-hell-is-going-on-in-here' look on his face. He took one look at Lloyd and knew.

"Poor Alex," Larson muttered half-aloud, "it was so unnecessary for him to have committed suicide."

"Just as well," said Maltby. "He would have gone to the chair. Murdered a man, didn't he?"

"He didn't murder anyone," Larson retorted.

Maltby looked meaningfully at the "corpse" and then at Larson.

"Just what do you call it, Larson? Love at first sight?"

"I said he didn't kill anyone at all. Show him what you found, Dr. Whitby."

The doctor showed him, and Maltby was stunned. Larson continued speaking.

"Analyze his name, Maltby. Mr. Andrew Lloyd. Take from it the 'ew' and the double 'l'. Now what does that leave you?"

"Why, it...it's...Andr...oyd. My God! He was an android. The Board of Directors gave us a cleverly made up robot for a boss."

The three men looked intently at one another as they heard the wail of an ambulance siren in the distance, coming nearer.

- END -

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- END -

Association for Computing Machinery Meeting, Philadelphia, Sept. 14 to 16, 1955, — Titles of Papers and Abstracts

The 1955 annual meeting of the Association for Computing Machinery took place at the University of Pennsylvania, Philadelphia, Pa., Sept. 14 to 16, 1955. About 130 papers and addresses were presented; some of these papers will be published in the Journal of the Association for Computing Machinery, available from the Association at 2 East 63 St., New York 21, N. Y.

Following are the titles, authors, and abstracts of the papers. The sessions and times when the papers were given, and the organizational connections of the authors, are stated in the program of the meeting, which was published in "Computers and Automation" for September, 1955, pages 32 to 34 (please read in sequence 32, 34, 33).

The following invited papers did not have abstracts:

Basic Principles of Computers,
Sessions 1 and 2:

23. General Structure and Basic Components, Dean Arden
24. Arithmetic of Digital Computers, James E. Robertson
25. Storage Devices, Norman R. Scott
34. Input and Output Equipment, Ragnar Thorensen
35. Instruction Codes and Programming, Alan J. Perlis, Purdue Univ.
36. New Developments and Future Trends, C. W. Adams

Experimental Mathematics,
Sessions 1 and 2:

60. Numerical Experiments in Algebra and on the Vibrations of a Membrane, G. E. Forsythe
61. Proper Values and Proper Functions of Sturm-Liouville Differential Equations, A. H. Taub
69. Conformal Mapping, John Todd and Philip Davis
70. Non-Linear Vibrations, J. Pasta and S. Ulam

For the numbers 85, 86, and 97, papers did not appear in the program.

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1. An Automatic Program for Matrix and Vector Operations

David P. Perry

An automatic program for matrix and vector operations has been written for the ERA 1103. This program will perform sum, product, inversion, eigenvalue and eigenvector calculations with matrices and vectors. The inverse operation uses the partitioning process supplemented by a gradient process. A floating-point system is used throughout with a scale factor assigned to each row of a matrix or to each vector or to each vector element. Matrix inversion may be performed on matrices or on submatrices of order 1 through 32.

2. An Interesting Set of Test Matrices

Mark Lotkin

For the testing of the adequacy and efficiency of any computing method it is clearly very desirable to have readily available a set of reliable test data. The material discussed below has been found by the author to be of great utility for this purpose. It is surmised that it may also be of interest to many others engaged in the testing of new techniques for the inversion of matrices and the determination of characteristic roots and vectors. Furthermore, the results may be of interest also for purely theoretical reasons. The exact inverses of a sequence of ten nonsymmetric and again of ten symmetric matrices of extremely poor condition, their determinants, and their largest and smallest characteristic roots and associated vectors as well, have all been calculated. These matrices were obtained by a simple modification of the well-known Hilbert matrix, and while they share many features characteristic of that matrix, they differ from it in many other important aspects.

3. An Iterative Procedure for Calculating the Eigenvectors and Eigenvalues of a Real Symmetric Matrix*

Richard E. von Holdt

The method seeks the eigenvector nearest an initial vector and consists of solving a system of linear equations for an increment to the trial vector. Orthogonality of successive iterates to eigenvectors is preserved. When an iterate is sufficiently close to an eigenvector the magnitude of the difference vector is approximately cubed at the next iteration. The method has been applied to several matrices of order four, eight, and sixteen, and in each case the number of iterations per eigenvector was less than five, independent of any local compactness of the spectrum of eigenvalues.

*Work done at Northwestern University for doctoral thesis.

4. Numerical Computation of the Characteristic Vectors of a Real Symmetric Matrix

Wallace Givens

An operating code for the computation of the characteristic vectors of a real symmetric matrix will be described. In "Numerical Computation of the Characteristic Values of a Real Symmetric Matrix" (Oak Ridge National Laboratory Report No. 1574) the computation of characteristic vectors for a general symmetric matrix was re-

duced to the case of a Jacobi matrix B, with $b_{ij} = 0$ for $|i-j| > 1$, and with the characteristic values known to high accuracy. When any $b_{i\,i+1}$ is "small" the straightforward solution of the first n-1 of the equations $(B - \lambda I)x = 0$ was expected to be inaccurate (cf. ORNL 1574, p. 3). This proved to be the case and a new method of computation has been devised.

5. EASIAC

Robert Perkins

EASIAC, the EASY Instruction Automatic Computer, is a pseudocomputer realized by means of a translating and interpreting routine in *MIDAC*. To the user, EASIAC appears as a small, relatively slow, decimal, floating point, floating address computer. Several of the common functions are included in the order code. Seven tallies for address modification, and two special instructions to facilitate use of subroutines are available. During translation and computation EASIAC checks for a number of "programming mistakes." If one is defected, computation ceases, and information on the type and location of the error and the history of the computation are printed out in programmer language. Designed primarily as a teaching device, EASIAC has also been useful on certain practical problems.

6. The 702 Auto Coder System

Hollis A. Kinslow

The Auto Coder system developed for the 702 will be described. This is a system of automatic coding designed to reduce programming efforts by having the machine itself assume certain clerical functions such as assignment of memory locations. In programs for typical data-processing applications there are common sequences of instructions which occur repetitively. Specific usage of such a sequence differs only in the value of certain constants and addresses. The Auto Coder utilizes a library of generalized subroutines and provides for their incorporation in a program by particularizing them according to parameters specified. The Auto Coder system is a logical extension of the assembly techniques currently used on the IBM Type 702 EDPM. The symbolic notation employed is substantially the same as that currently in wide use by EDPM customers. The system is designed primarily for commercial applications although it is also useful for engineering calculations. Provision is made for handling several types of subroutines designed to produce a program which is as effective as possible.

7. Automatic Encoding System I

E. K. Blum

Automatic Encoding System I is designed to mechanize the process of translating mathematical formulas into programs of coded instructions for a digital computer. The system consists of a formulation language, an encoder, and a digital computer. The formulation language closely resembles ordinary mathematical language, and is general enough to describe primitive recursive functions. The encoder is a device which receives the mathematical formulations as input and produces the necessary computer instructions as output. An actual Encoder is described. It is constructed by loading a computer with certain routines. Although designed for computers of a particular type, the Encoder embodies general principles applicable to most computers. Certain desirable features of the computer in such a system are suggested.

8. Transcode

J. N. P. Hume

Transcode, a system of automatic programming for FERUT, has been in operation since September, 1954. It enables FERUT, a fixed-point, one-address, binary machine to operate as a floating-point, three-address, decimal machine. An analysis of Transcode applications will be presented and a breakdown of the time the machine used the Transcode systems during the past year will be discussed.

9. Script, A General Purpose Planning System for the IBM Electronic Data Processing Machine Type 702

Charles E. Thompson

The SCRIPT system is a program assembly, compiling, and generating routine which can be applied to a wide variety of data processing applications, including both scientific and commercial problems. The system provides a variety of coding techniques including the use of a comprehensive library of floating point subroutines for scientific calculations and a variety of input-output, record rearrangement, and report preparation "sub-operation" for commercial applications.

Throughout the development of SCRIPT an attempt was made to keep the coding rules to a minimum so that in preparing a program the emphasis is on the application, rather than on the coding system used.

10. The ERMETH and Other European Digital Computers

John R. Stock

In Europe, at the present time, there are a number of automatic digital computers primarily intended for scientific computation in operation. For business applications, equipment of intermediate size is commercially available. At the Swiss Federal Institute of Technology, the Zuse relay computer has been replaced by an electronic machine of moderate speed using magnetic drum storage. Although conservative in engineering design, the machine has an interesting logical organization, characterized by the simultaneous incorporation of fixed- and floating-point operation, by a large number of index registers (B-tubes), and by various conveniences with the input and output facilities. Other of the European developments also show noteworthy and practical features.

11. The Logical Design of CONAC

Stanley Frankel

CONAC is a general-purpose, serial, binary, drum-memory computer built by the Continental Oil Company research laboratories, intended primarily for the numerical solution of partial differential equations. Several features increase its speed in this use: partial word recording, order execution from two circulating registers, zero- or two-address instruction word structure to facilitate minimum latency coding. Floating-point operations are speeded by a scale factor and a shift order using a signed exponent. Exponents may be combined algebraically and incorporated in a shift order which can be executed directly from a circulating register. Square root is performed as an elementary operation by a process akin to nonrestoring division. The logical complexity of CONAC is considerably less than that of comparable computers currently available.

12. The System Design of the IBM Type 704

G. M. Amdahl and J. W. Backus

The IBM Electronic Data-Processing Machine—Type 704—is a new large-scale, high-speed, digital computer intended for scientific and technical applications. Experience derived from the use of 18 IBM 701 calculators enabled the determination of a number of additional logical functions which would be of considerable aid in meeting the expanding needs for more powerful computing facilities. This paper will describe the system and logical organization of the Type 704.

13. The NATPAC General Purpose Digital Computer

William E. Smith

A general-purpose, digital computer is described which operates in the binary number system and in the serial mode. The computer circuitry contains only a few types of circuits. There are 26 instructions which the computer can obey. Most instructions are completed in ½ millisecond; a few require 10 milliseconds. Two thousand and forty-eight words of 40 bits each are stored in the computer memory. Several unique details of construction are the use of water cooling, the standardization on one type tube (5670), the extensive use of plug-in units, convenient test points, built-in flip-flop (static) test circuits, a magnetic, regulated power supply, and small size for its computational capabilities.

14. Experience with the Era 1103 Computer

Charles J. Swift

For over a year, unusually close cooperation has been maintained between all users of the ERA 1103 computer. This talk will attempt to evaluate the machine's features in terms of a variety of uses. In particular, the memory system, two-address logic, addressable registers, special commands, the tape system, and the input-output registers will be considered in the light of uses which range from real-time simulation to one-shot problems. In many respects the machine has proved very effective. Some features did not prove as useful as expected, while some unpredicted features, discovered by experience, proved useful.

15. Wind Tunnel Data Reduction Using Paper-Tape Storage Media

W. R. Hoover, J. J. Wedel and J. R. Bruman

Wind tunnels generate extremely large quantities of raw data. For wind tunnels to operate efficiently it is necessary to provide for rapid accumulation of raw data and an efficient data-reduction program. The purpose of this paper is to discuss the complete data-reduction program used for the two supersonic wind tunnels of the Jet Propulsion Laboratory and the reasons for using a punched paper-tape medium. The mathematical problems of wind-tunnel data reduction, and the problems encountered in using paper-tape for data reduction are discussed. The paper includes descriptions of the equipment designed at J.P.L. for the rapid accumulation of raw data and of the tape-handling equipment auxiliary to the ElectroData Model 203 digital computer used for the computations. Comparisons will be made between the new system and the previous system using punched cards with an IBM Card-Programmed-Calculator.

16. Sequencing and Selecting Items on Magnetic Tape

Norman Grieser

The ELECOM File Processor is a special-purpose, electronic data-processing machine for sequencing, collating, selecting, and separating items recorded on magnetic tape. Its operations are designed to work in close collaboration with a medium-speed, electronic computer so that the computer: (1) is never required to sequence items; and (2) never has to 'search' for pertinent data. The result is a balanced electronic system with work-output capabilities many times that of a general-purpose computer working alone. Details of the File Processor operations will be examined, together with an example of the operation of the equipment in a typical data-handling application.

17. File Reference

J. A. Postley

With the advent of the large-scale, electronic, data-processing system, the problem of efficient reference to a large file of information associated with such a system has evolved. The problem breaks down into the two basic parts of: (1) locating the desired information in the file; and (2) gaining access to the information so located. Efficiency of solution may be judged by the degree of optimization of the factors of maximum file size, cost of storage system, rate of reference to the file, and pipeline time for any particular reference to the file. Suitability of mechanisms, a function of the requirements established by these criteria, can also be determined.

18. Tape Identification and Rerun Procedures

L. Eselson

In the daily operation of large-scale, data-processing systems, it is necessary to guard against undue loss of computer time resulting from interruptions to the normal operating procedures. Typical interruptions are: (1) failure of personnel properly to execute such operations as mounting correct tapes or observing starting procedures; (2) failure of the computer to execute the programmed instructions due to component failure, unreadable tapes, or loss of power; and (3) removal of the problem from the machine to make way for one of higher priority. A general procedure for tape identification and rerun has been developed which is applicable to all data-processing runs. This procedure provides for a check on manual operations and also provides frequent and convenient rerun points. Modifications of this procedure are available for mathematical routines.

19. Automatic Routines for Commercial Installations

Mary K. Hawes

The need for automatic routines to prepare programs for processing large volumes of data has been recognized for several years. Generating routines for sorting, merging, and tabulating are common. However, prior to the development of the Data-Processing Compiler, no compiling system was available to produce, in its entirety, a desired data-processing routine from a description expressed in pseudo-code and applied in conjunction with previously stored information. DPC has been designed for the layman. One of its pseudo-codes consists of variable length English words. Subroutines, generating routines, descriptions of files and of "nouns" make up the library. The paper emphasizes the layman's use of the Data-Processing Compiler.

20. The ELECOM 125 Compiler

Leon Nemerever

The ELECOM 125 Automatic Code is a compiler of the relative-address type which is capable of producing a running program or a composite sub-routine. To produce either result, the automatic code routine requires only that the programmer submit a paper tape on which are punched the names of the sub-routines comprising the program desired. In return the automatic code yields:

(1) a complete program (automatically addressed) on magnetic tape; and (2) an edited record of the compiled program showing how each line of coding was translated from the original (sub-routine) coding. Additional features of this automatic code are complete freedom of cross references between sub-routines and the incorporation of many consistency checks formerly executed by hand.

21. Compiler and Assembly Program for the IBM 704

J. A. Porter and D. L. Shell

This paper is a full description of the General Electric Symbolic Programming and Assembly System for the IBM 704. This system allows programs to be written in a symbolic form using a mnemonic operation code with symbolic locations and address, where the address, tag, and decrement are written as one expression without the use of fixed fields. Additional assembly instructions have been added to the list of operation codes to allow greater flexibility and ease in preparing programs. The assembly system translates all instructions and assembles them into a program. In addition it inserts sub-routines into the program from a magnetic tape library. During the process of assembling and compiling, a thorough check is made for possible errors and inconsistencies in the program. These errors, in most cases, will not stop the assembly process but will be notated on the final listing of the assembled program.

22. Compilers with Mathematical Symbol Input

A. E. Roberts, Jr.

Compiler techniques offer a practical compromise between reduction of programming time and efficient utilization of a computer. More widespread application of high-speed computing systems is encouraged by pseudocode schemes for problem input, especially by those of universal character as mathematical symbolism. From such input the compiler for a particular computer prepares a running program in basic computer code. Illustrative compiler developments for the 1103 computer system will be described. Internal organizing of subroutine linkage is automatized by compiler-interpreter techniques. As pseudocode, parenthesis-free mathematical symbolism is used; its simple uniform syntax facilitates mechanizing computer-internal formal transformations within the pseudocode language. Programming techniques used in formula translation will be discussed.

26. Sorting by Address Calculation

Earl J. Isaac and Richard C. Singleton

A new technique of sorting on a general-purpose computer has been developed and tested. Items were sorted on the drum of the Datatron computer in less than one-half the time of conventional merge methods. Prior knowledge or sampling is used to estimate the distribution of keys; from this, a function for translating the key to an approximate memory location is constructed. A memory address is calculated for an item of data. If the location is unfilled, the item is inserted; if not, the item is interfiled, moving previously inserted items according to a simple rule. All items are in sequence after each insertion. If the number of items exceeds the internal memory capacity, one or more tape passes are used to rough-sort by key range into manageable groups.

27. Criteria for Comparing Methods of Sorting

Benjamin L. Schwartz

Three closely-related mathematical criteria are presented for evaluating and comparing methods of sorting data. These criteria are applicable to any sorting method and are independent of any machine. They employ the concept of the number of comparisons required to effect the sorting. The advantages and disadvantages of each of the three are discussed, and simple examples worked out to illustrate them.

28. Sorting and Merging on Electronic Data-Processing Machines

R. L. Cline

Sorting and merging operations are an integral part of many commercial and scientific applications on electronic equipment. In some instances the practicability of placing an application on electronic equipment is dependent on the speed of a sorting operation. The purpose of this paper is to evaluate sorting techniques such as internal sorting and tape merging, for different types of electronic, data- processing machines. The blocked-record technique is considered as to its effect on the optimization of the sorting operation. To eliminate the time-consuming task of writing a sorting program for each specific application, generalized routines have been prepared. Given the sorting parameters for a given file of either fixed- or variable-length records, these routines automatically prepare a program to process that file.

29. Sorting

Edward H. Friend

The present economic impracticality of large-scale "random access" storage suggests that sorting is and will continue to be one of the most important logical functions performed by electronic data-handling equipment. A comparative analysis of all generally known sorting methods utilized for the ordering of data stored in high-speed, intermediate-speed, and low-speed memory media (as well as combinations thereof) is presented. The effect of such features as simultaneous read and write, internal and external buffers, backward reading, high-speed rewind are considered in evaluating the methods of sorting data stored in the low-speed medium (magnetic tape). Punched-card sorting is also considered. In a special appendix several existing data-processing systems are analyzed with respect to the sorting procedures discussed.

30. An Unrestricted Method of Stepwise Integration

J. H. Allen

The integration process described here will determine an area under a curve from the first data point to each new data point introduced. While most quadrature formulas restrict the argument to equal intervals, this method overcomes that limitation by a changing interval which is a function of the endpoints of the range under consideration at any particular step. Simpson's rule is combined with the divided-difference interpolation formula and arranged such that the integral is a function of three input data points only. This is then applied to the data points to obtain the area for all the odd-numbered points. To obtain the area for the even-numbered points, Newton's "three-eights" rule is combined with the divided-difference interpolation formula and applied to the first four data points, and the area obtained for the fourth point. The area for the remaining even-numbered data points can then be determined by repeated application of the modified Simpson's rule formula.

31. The Convergence of Iterative Methods for Solving Linear Systems

Alston S. Householder

Recursions of the form $\mathbf{x}_{\nu+1} \mathbf{h} + \mathbf{H}\mathbf{x}_{\nu}$ represent most iterative methods for solving linear systems, and convergence requires that $\lim \mathbf{H}^{\nu} = 0$. Various criteria are known, but those most readily applied are often too restrictive. In this paper a class of readily constructible $||\mathbf{H}||$ will be considered. These are such that $||\mathbf{H}|| < 1$ always ensures convergence. Most, if not all, known criteria can be phrased in these terms, and new ones can be developed. These should be especially useful in solving the difference approximations to differential equations. Applications can be made also to the determination of bounds for the latent roots of a matrix.

32. Accelerating Convergence of Iterative Processes

J. H. Wegstein

A technique is discussed which, when applied to an iterative procedure for the solution of an equation, accelerates the rate of convergence if the iteration converges and induces convergence if the iteration diverges. An illustrative example is given and the application of the method to simultaneous equations is discussed.

33. Numerical Integration for the Digital Computer

S. G. Campbell

The ORACLE system of numerical integration consists of general Gaussian and Newton-Cotes type programs which are interchangeable and which have provision for arbitrary subdivision of the interval of integration, the selected formula being applied to each subinterval. Floating point and multiple numerical quadrature programs are included, along with a similar program for the numerical integration of arbitrary systems of first order ordinary differential equations by the Runge-Kutta method. Special programs for evaluating special functions with integral representations are compared with the general-purpose programs, and criteria are established for determining when numerical quadrature is an efficient means of evaluating mathematical functions, and for selecting the proper method. Numerical quadrature is often effective in the complex plane.

37. A Method of the Numerical Solution of End Value Problems

E. M. Gettel and D. L. Shell

This paper describes a method for the direct solution of end-value problems which are stated as second order differential equations with boundary conditions. The method is an adaptation of known procedures and consists primarily of two steps: (1) the transformation of the second order differential equation and boundary conditions into a first order integral equation; and, (2) the conversion of the integral equation problem into a set of simultaneous linear algebraic equations by a means of a quadrature method. The original problem is thus reduced to a form which can easily be solved. An example of the method is considered. A generalization of the method is discussed.

38. A Method for Computation of Solutions of the Equation $\Delta\psi(x,y,z) = b(y,z)\ \psi\ (x,y,z)$

Stefan Bergman

By the transformation $X = \frac{1}{2}x$, $Z = \frac{1}{2}(iy + z)$, $Z^{\circ} = \frac{1}{2}(iy - z)$ the above equation becomes $L(\psi) = \psi_{XX} - \psi_{ZZ^{\circ}} - B(Z,Z^{\circ})\psi = 0$. We assume that B is a polynomial. In order to solve boundary value problems, one uses sets of particular solutions (see Bergman, Quarterly of Applied Math. 4 (1946), p. 233). These solutions can be written in the form $\sum_{n=0}^{m} X^{2n}\psi^{(mnM)}(Z,Z^{\circ})$ and $\sum_{n=0}^{m} X^{2n+1}\phi^{(mnM)}(Z,Z^{\circ})$.

The $\psi^{(mnM)}$ can be determined using two different formulas:

I. $\psi_1^{(mnM)} = \delta_{mn} Z^M + \sum_{\nu=1}^{m} q^{(mn\nu)}(Z,\bar{Z}) \int_0^Z \int_0^{Z_1} \cdots \int_0^{Z_{\nu-1}} Z_{\nu}^M dZ_{\nu} \cdots dZ_1$,

$\delta_{mm} = 1$, $\delta_{mn} = 0$ for $m \neq n$. Here $q^{(mn\nu)}$ are conveniently chosen solutions of a system of ordinary differential equations.

II. $\psi_2^{(mnM)} =$

$$= \left[\delta_{mn} Z^M + \sum_{\nu=1}^{m} \int_0^Z \int_0^{Z^{\circ}} \int_0^{Z_1} \int_0^{Z_1^{\circ}} B \cdots \int_0^{Z_{\nu-1}^{\circ}} \mathfrak{z}^{(mn)} dZ_{\nu} dZ_{\nu}^{\circ} \cdots dZ_1 dZ_1^{\circ}\right]$$

where $\mathfrak{z}^{(mn)} = Z^M$ and $\mathfrak{z}^{(mn)} = \psi^{(mn+1M)}$ for $n < m$. Similar formulas hold for the $\phi^{(mnM)}$. The author discusses methods for evaluation of the above indicated solutions.

39. A General Code for Certain Boundary Value Problems

Stanley Katz and Jack Warga

A large number of elliptic and parabolic partial differential equations are defined over domains which can be approximated by polygons with edges parallel to the coordinate axes. A general program has been developed for the iterative solution of such problems. The program is applicable to arbitrary regions of the above type, through the interpretation of certain numerical data describing the particular geometry.

40. General Code for Elliptic Equations*

Jack Heller, H. B. Keller and Samuel Schechter

A general, two-dimensional, elliptic equation is replaced by a system of second-order difference equations. A code to solve these difference equations by an iterative implicit scheme is generated to allow for a nonuniform mesh, multiply-connected regions and various boundary conditions. The method of generation involves scanning of pointwise and boundary condition specifications. For the UNIVAC this code can handle up to nineteen coupled elliptic equations on mesh of 59 x 100 points.

*This work is supported by the U. S. Atomic Energy Commission.

41. An Optimizing Routine for the IBM Type 650

Barry Gordon

The IBM Type 650, a stored-program, magnetic-drum computer, uses a one-plue-one-address instruction to facilitate minimum-latency or optimum programming. Although information may be stored at random on the drum, the machine's computing speed is markedly increased (quite often by a factor of four) by the judicious location of data and instructions. A routine, now in use in the 650 installation in the author's company, enables the machine to optimize its own programs. Writing a program to be optimized by the machine requires virtually no more effort than sequential coding, relieving the programmer of a job which is pains-taking, time-consuming, and highly subject to error. Programs as long as 2000 words, the capacity of the 650 memory, can be optimized by this routine.

42. An Integrated Computation System for the ERA-1103

Walter F. Bauer

The system involves the storage of a complete set of service routines and subroutines in the large amount (16,384 words) of directly accessible magnetic drum

(MD) storage. The amount of program data stored and handled manually, and computation time for data read-in are greatly reduced. A symbolic-form, decimal assembly program with subroutines for program preparation, and service routines for program debugging and data transfer are immediately available at the control console. All service routines are designed to initiate appropriate transfers between MD and electrostatic storage before and after execution and to make appropriate checks of data and memory sums. Whenever needed, restoration of the utility routine library data is quickly made by a transfer of the library to MD from its semi-permanent location on magnetic tape.

43. Analysis of Programming Mistakes

J. Wright

This paper describes the use of programming-mistake statistics in improving the procedures at a computation center, based on recent experience in programming for the MIDAC computer. Two modes of programming for the MIDAC are available, component coding (a method of semi-automatic programming using a translation program) and direct MIDAC coding. Mistakes in programming were grouped into three main categories (those involving logic, the component code, and the MIDAC code) and then further divided into several sub-categories. By examining the programming statistics, the chief sources of mistakes are revealed. The proper choice of categories will often suggest improvements in procedures. Data are presented for MIDAC.

44. Prevention of Propagation of Machine Errors in Long Problems

J. H. Brown, John W. Carr III, Boyd Larrow, and J. R. McReynolds

Complicated problems in partial differential equations of the initial value type require calculations that may run into several billions of operations, with the final answer being dependent on the correctness of all the previous calculations. Even with the highest-speed computers available today, the probability of one or more machine errors in such a long problem is extremely high. This paper discusses the changes made in circuitry and programming techniques for the MIDAC, originally a completely unchecked computer, in order to minimize the probability of undetected errors. Discussed are built-in memory sums, parity checks, rollbacks, programmed memory sums, and other programmed techniques that parallel to some extent the built-in features of the UNIVAC and other fully checked computers. A comparison of built-in versus programmed checking on large problems is also made.

45. Multiple Regression and Correlation Analysis on the IBM Type 701 and Type 704 Electronic Data Processing Machines

F. S. Beckman and D. A. Quarles, Jr.

Multiple regression and correlation analysis is a powerful statistical tool which may often be used advantageously for prediction and for gaining better understanding of relationships between variables. When the number of variables and observations is substantial, the procedure involves a considerable amount of computational work. A program developed for the IBM Type 701 computer receives as input as many as 1022 observations on up to 50 variables and computes and prints as output the means, standard deviations, simple correlation, regression and partial correlation coefficients, multiple correlation coefficient, and standard error of estimate. Some applications will be discussed. A similar program is now being prepared for the IBM Type 704 computer, and additional features of this program will be mentioned.

46. Similarity Analysis on the Illiac

David J. Fitch

A program for doing similarity analysis on the Illiac was written which will classify up to 90 people. This method of analysis starts with a matrix of agreements or any other index of relationship, and takes those two individuals who have the highest agreement and combines them into a new "corporate" individual. The average number of agreements between this corporate individual and the other individuals is then computed thus reducing the order of the matrix by one. This is repeated until the matrix is reduced to some arbitrarily small size. The results of the analysis yield pyramided ordering of groups with fewer and larger groups as the apex is approached. Results obtained by using this method of analysis in classifying senators of the 83rd Congress will be presented.

47. Computing Experience with Linear Programming and its Variants

William Orchard-Hays

The application of linear programming to complex problems gives rise to the handling of large matrix problems. The simplex method has proven to be the most expedient of any tried but, since this is essentially Gaussian elimination, numerical techniques for handling it have definite limitations, both with regard to running time and memory size. RAND's simplex codes from the IBM 701 have been designed, through revisions to the method and special compiling routines, to maintain great precision and facilitate checking, to be adaptable to many variations, and to be as automatic in operation as possible. Several quite large models of considerable variety are discussed along with the prospects for future improvements, both in theory and in coding techniques.

48. New Applications of Linear Programming

Joseph V. Natrella

New applications of linear programming are being made by the Air Force. The Univac has proved suitable. Two satisfactory codes have been written, a simplex code and a transportation code. It has been more difficult to develop acceptable formulations. One new application deals with the efficient allocation of combat aircraft to competing activities. It is desired to maximize the number of aircraft deployed for combat while allocating enough aircraft to train crews to fly them. Another application is in the logistics-feasibility area. There are stated resource- and priority-limitations on materiel such as aviation fuel and ammunition. Intra- and inter-command combat sortie relationships may extend into game theory when both U. S. and enemy potential sorties are considered.

49. A Method for Finding the Roots of Arbitrary Matrices

John Greenstadt

Jacobi's iterative method for diagonalizing a real symmetric matrix, A, consists in performing a sequence of orthogonal transformations on A. Each such tranformation is chosen so as to annihilate a selected off-diagonal element, and the entire set of such elements is swept through in some systematic manner. The entire process is iterated until the off-diagonal elements all fall below a fixed error limit. The diagonal elements of the transformed matrix D are then the roots of A. The method has been generalized as follows: The orthogonal transformations are replaced by unitary ones, and instead of diagonalizing A it is triangularized. The resulting triangular matrix T

has the roots of A for its diagonal elements. If the accumulated transformation is preserved, it is possible to obtain the eigenvectors of A as well.

50. A New Method for Rapid Formation of Characteristic Equation of a Complex Matrix

E. G. Kogbetliantz

For a complex matrix $A = ((a'_{ij} + a''_{ij}\sqrt{-1}))$ of large order the numerical evaluation of the complex coefficients $c_m = c'_m + c''_m\sqrt{-1}$ of its characteristic equation $f(z) = \sum_{m=0}^{n} c_m z_m = 0$ represents in itself a difficult computational problem. A new method for computing c_m, $0 \geq m \geq n$ is proposed. This method seems to substantially simplify and accelerate the formation of $f(z)$. It is based on the prior reduction of A to a pseudo-jacobian form $B = ((b'_{ij} + b''_{ij}\sqrt{-1}))$ with $b'_{ij} = b''_{ij} = 0$ for $|i-j| \geq 3$. For the matrix B, a system of recurrent relations well adapted to electronic computing equipment are formed and then c_m are easily computed. The reduction to a pseudo-jacobian form is done in such a way that the eigenvalues are preserved.

51. An Inverse Characteristic Value Problem

Arthur C. Downing and Alston S. Householder

In studying simple molecules, the following nonlinear problem is of considerable interest: given the n x n real, symmetric, positive definite matrix G, determine a real diagonal matrix F such that the determinant $|G - \lambda_i F|$ vanishes for a given set of n real numbers $\lambda_1, \ldots, \lambda_n$. This paper presents a second-order, iterative procedure for improving an approximate solution of such a problem, assuming that a solution exists.

52. Codes for the Solution of Systems of Linear Algebraic Equations

Wallace Givens

If the equations are $AX = K$ (with A m by n, X n by s and K m by s), a first code gives $TX_1 = RK - SX_2 = L$, where T is upper triangular. A back substitution process then completes the solution to $X_1 = T^{-1}L$. The novelty lies in the use of ½ n(n-1) plane rotations to make the first reduction and in the inductive reduction of the amount of data handled. Scaling each column of A and of K to have norm slightly less than one permits fixed point operation throughout the first code. With 10 A the second difference operator ($a_{11} = -.2$, $a_{i\,i+1} = a_{i+1\,i} = .1$ and other $a_{ij} = 0$) and $K = (.1)1$, a Univac calculated A^{-1} of order 49 in 58 minutes with maximum error in any component of $10^{-2}A^{-1}$ (minimum scaling) of 262.10^{-11}

53. An Evaluation of Automatic Programming

Stephen E. Wright

Automatic programming methods arose in response to an urgent need to reduce programming effort, thereby conserving the inadaquate supply of trained personnel. Sufficient experience has now been accumulated to appraise these methods. Comparisons of automatic programming schemes currently in use show a need for more precise definitions and standards in this field. Many factors influence the development of such schemes; among others, number systems, size and capability of computers, types of application, competence of programmers, organization and training of programming groups. Analogies with the development of language yield insights into the communication between programmer and computer, and into the problems of training programmers. Future trends in automatic programming, including its possible impact on computer design, will be discussed.

54. A General System for Handling Alphameric Information on the 701

Bruce G. Oldfield and Robert H. Bracken

This paper presents a systematic approach to the problem of handling alphameric information on the IBM 701, a computer designed primarily for scientific computation. The approach has been to develop "building blocks" which greatly simplify the coding of a particular alphameric problem. Certain fundamental problems and the particular decisions reached are discussed. Interesting features of these "building blocks," namely programs and subroutines, are discussed and include the following: (1) general card input and printer output routines; (2) packing, code changing, relocating, clearing, unpacking, whole numbers to digits, digits to whole numbers, tape read, and tape write routines; (3) a general insert and delete program; (4) a general select and rearrange program; and (5) a general sorting program.

55. How to Solve Simple Problems Economically on a High-Speed Digital Computer

Bruce G. Oldfield

This paper is a discussion of techniques which can greatly simplify the solution of certain types of computational problems on any high-speed computer. These techniques are especially important for an "open shop" type of organization. A particular interpretational system, coded for the IBM 701, will be used as an illustration. This system is easy to learn, fast to code, and provides one of the best means yet devised for getting answers quickly and with a minimum amount of effort whenever it is applicable. The general type of problem amenable to this particular system is one in which it is desired to perform a set of operations on a group of data and constants and to repeat these operations with the same constants, on successive groups of data.

56. Factors Influencing Choice of Electronic Data-Processing Systems for Business Use

Howard S. Levin

Management is faced with difficult decisions in selection of electronic data-processing equipment to meet the information needs of a business. A survey to develop basic factors for such decisions is undertaken early in most electronic programs. The organization and content of such a survey are elements for careful consideration. Company organization, information flow, present costs, and uses of data are developed to provide a model of the information system. Competitive computer systems with various input and output equipments are then evaluated against this model. It is necessary to weight cost of computers and peripheral equipment, acquisition basis, maintenance cost, programming cost, and organizational effort in this process against cost reductions, improved information availability, or other management factors.

57. The Computer Specialist's Role in a Business Application Group

Helen Meek and Leon Gainen

Many business firms are entering the data-handling field without previous experience with such large-scale, digital computers as the 702, 705 and the Univac. Men with experience in business systems and procedures have need for guidance and counsel on how to use the new equipment efficiently in commercial applications. A number of the services that people trained on computers can render will be discussed. Typical examples include generalized block diagrams for sorting operations with parameters unspecified so that particular sorting needs can be fulfilled merely by specifying values for these parameters.

58. Justifying Business Applications of Automatic Computers

Ned Chapin

Although "intangible" considerations are not ignored, main attention is given to "dollar-and-cents" considerations, because in business the logical justification for using an automatic computer can only be that it is more profitable to use an automatic computer than it is to use any alternative equipment. The problem of justifying business applications of automatic computers therefore becomes one of determining whether or not the use of an automatic computer is the most profitable alternative. Because automatic computers are still comparatively new, persons in responsible positions are often uncertain as to what method to use to determine the profitability of the various alternatives. The paper presents two of the most appropriate methods, the MAPI, and the Capital Recovery.

59. The Function of Automatic Programming in Business Data Processing

R. J. Rossheim

The purpose of this paper is to cross the middle ground between creators of automatic programming systems and the eventual users in business data-processing installations. Some practical objectives are suggested which may serve as a guide to the creators and which may, also, act as criteria whereby potential users can appraise and compare various programming systems.

Pseudo-codes, sub-routine libraries, compiling methods, operational techniques, application procedures are discussed.

62. A Description of a Cooperative Venture in the Production of an Automatic Coding System

Wesley S. Melahn

Representatives of Douglas, Lockheed, North American, USNOTS - China Lake, Ramo - Wooldridge and The RAND Corporation, who formed the Project for The Advancement of Coding Techniques, brought together quite different computing philosophies, practices, and aims. This paper surveys and evaluates some of the ideas that were suggested during the search for an improved way of programming problems for machine solution. It attempts to justify the choices that were made in the design of PACT I, a program that produces efficient machine language code for the 701 computer from a concise description of the steps in a calculation.

63. The Pact I Automatic Coding System for the IBM Type 701

C. L. Baker

Pact I is an automatic coding system now in use at several Southern-California 701 installations which is simpler and more nearly algebraic tnan machine-language coding. Problems written in *Pact I* are translated by the *Pact I* compiling program, before execution, into actual machine orders. The pseudo-orders are written in a single-operation single-operand form. Emphasis has been placed on the mnemonic character of the code and the direct specification of operations and operands. The resulting orders are fixed point, and arithmetic scaling may be specified or automatically determined. Various special operations are employed to facilitate standardized manipulations such as loop writing and the handling of arrays. *Pact I* also permits the use of subroutine libraries already in existence.

64. Logical Organization of the Pact I Compiler

Owen Mock

PACT I is a 701 compiler designed to provide a mechanism for simple and direct coding of arithmetic problems. A principal aim in the development of PACT I has been to explore techniques for writing compilers. In this paper, general results of the PACT Committee's compiler-writing experience are discussed. In particular, considerations are examined which permitted the division of the compiler into individual programs, each operating as self-contained units. Finally, logical characteristics of programs compiled by PACT I, which facilitate check out, are described.

65. Ferroelectric Applications to Digital Computers

Ramon Alonso and Thomas Conley

This report is a survey of ferroelectric applications to digital computers. It describes both storage and switching devices which are basic to any computer. Digital information can be stored in a matrix of ferroelectric crystals or ceramics in a two-coordinate, coincident-voltage system. The matrix can be made on a thin ferroelectric crystal or ceramic sheet by painting the rows on one side and columns on the other side with silver paste. The information can be obtained from the matrix by a pulse transformer or integrating condenser. Multi - position switching can be accomplished with ferroelectric condensers. The logical circuitry can be painted directly on the sides of thin ferroelectric ceramic sheets.

66. Development of Criteria for the General Use of Magnetic Drums

Bill L. Wadell

This paper describes the development and use of a group of design criteria affecting the selection and logical design of a magnetic drum as a buffer store. There are a number of formulas developed, and the basic assumptions circumscribing their use are detailed. The formulas used are demonstrated by describing two systems where the criteria were used in design. The first system involves a special format control for printing and punching, and the second is a buffer drum system designed to satisfy a data processing and collection system having a unique set of requirements as to sampling rates and location of data assembly points.

67. The IBM 705 EDPM Memory System

R. E. Merwin

The IBM 705 memory system utilizes magnetic cores both as a storage element and also in a matrix-address selection system. The core compares very favorably with other means of storage with respect to such factors as speed, reliability, size, cost, life, and the simplicity of associated electronic circuitry. The memory consists of a main 20,000-character unit and a 512-character storage unit. Both are three dimension coincident current systems with the larger containing 35 planes of 4000 cores each and the other consisting of seven planes of 512 cores each. The basic memory cycle is 9 microseconds long when operating with the input-output units or on internal transfer of data. When operating with the central processing unit a 17-microsecond cycle is required. Data may be transferred within memory in five-character blocks, and the five-character instructions are transmitted to the control unit in one memory cycle. Transfers between memory and the input-output and arithmetic units are serial by character. Use of the magnetic core matrix switch greatly reduces the electronic equipment required to drive the memory. Simplified circuitry requiring no adjustments eliminates any maintenance time required for making routine adjustments. Indefinite life of the core eliminates any replacement problem of the basic storage element itself.

68. Core Storage—An Evaluation of Present Techniques and Future Developments

Raymond Stuart-Williams, Milton Rosenberg and M. A. Alexander

The present status of magnetic core storage is reviewed briefly. The core memory which was added to the RAND computer early in 1955 and which is the largest high-speed memory yet constructed, is described in detail. From the experience gained during the design and operation of this, and other memories, a specification has been evolved which will greatly improve the reliability and ease of maintenance of future core stroes. The future of these devices is discussed, with particular emphasis being placed upon the importance of core-transistor techniques.

71. Producing Computer Instructions for the Pact Project I Compiler

Robert C. Miller, Jr., and Bruce G. Oldfield

PACT—Project I is an experiment in automatic programming for a high-speed digital computer (IBM 701). The PACT program is designed to produce a machine-language program from a symbolic program which is more nearly algebraic than the machine language. The production of the proper machine language is a basic problem in any compiler. This paper describes how the problem was solved for that part of PACT which is primarily concerned with the arithmetic operations and scaling. Other methods which were considered are compared with this method. Some discussion is given about its use on other computers and by other possible compiler programs.

72. Loop Generation

Jules I. Schwartz and Gus S. Hempstead

This paper describes the coding techniques used in the loop generation routine of PACT I. The use of memory and tape units and a discussion of the type of machine code generated for given cases is included. The incorporation of certain orders in PACT coding, and the results given for these orders are discussed. The emphasis is on problems encountered in the generation of loops and how they were overcome, and on thoughts for possible improvements in this type of generative routine.

73. Semi-Automatic Allocation of Data Storage for Pact I

Richard C. Luke and John I. Derr

The purpose of this paper is to discuss the system that was developed for realizing the allocation of high-speed memory for all data referred to in PACT instructions. In addition, the reasons for choosing this particular system will be explained. The system permits the user, *at compile time*, to identify one- and two-dimensional arrays of data as such by specifying the maximum range of the arrays in either dimension, and to constrain the storage allocated to several variables to (1) overlap, (2) be such that any one succeeds or immediately succeeds any other, and (3) coincide with explicitly specified relative or absolute locations.

74. Conclusions after Using the PACT-1 Advanced Coding Technique

H. G. Martin

From experience with the PACT-1 Advanced Coding Technique as used on the IBM Type 701 Data-Processing Machine, a comparison is made between this coding system and 'machine language' coding with reference to coding time, number and types of errors, 'debugging' time and experience needed by the coder. In addition, there are suggestions as to improvements that can be made in future systems and comments substantiating decisions made while writing the specifications for the system.

75. The Optimization of a Non-Saturating Single Transistor Flip-Flop

R. K. Gerlach and D. O. Miles

Th' is a complete static analysis of the point contact transistor operated as a nonsaturating bistable element. In an effort to attain a reliable computer component, it was necessary to impose certain limitations on some of the transistor parameters. Considering these limitations, it is possible for one to derive four nonlinear, simultaneous equations completely describing the necessary criteria which must be met in order that the circuit be nonsaturating, have two stable states and operate within the prescribed limits of transistor power dissipation. The equations can be solved by elimination of variables and an application of Cardan's formula to yield an infinite number of practical, optimum circuits. From this large range of the four external parameter particulars, it may be shown that those circuits with a certain range of V_e are more reliable than others. Curves are provided to describe the above effects. Data is provided to show the operation of the circuits in tests. Thus the evolution of the optimization of the circuit is presented from theoretical considerations to the practical use of the findings.

76. A Set of Direct-Coupled Transistorized Logical Elements for the 10^{-7} Second Range

W. J. Poppelbaum

Circuits for the logical elements *and*, *or*, and *not*, as well as flipflops and gates, are discussed, with particular attention paid to the tolerance conditions. Special attention is paid to the design of fast flipflops. Several types are treated: flipflops with drift stabilization, flipflops with particularly easy tolerance conditions and maximum-speed flipflops. In the latter case, the consistent use of high injection levels in grounded-base-amplifier emitter-follower devices is discussed. Examples of designs using the above logical elements as plug-in units in a 5-bit adder and in control circuits are given. Reliability figures for a shifting register and a simplified arithmetic unit are quoted. These figures seem to warrant the use of direct-coupling in transistorized machines in the near future.

77. Advances in Beam Switching Tube Computer Techniques

John R. Bethke

The trend of computers is toward high-speed, digital techniques with an increase of accuracy, life expectancy, reliability, and, at the same time, a decrease in size and power requirements. The Magnetron Beam Switching Tube, developed by the Burroughs Research Center and currently available in production quantities from Haydu Brothers of New Jersey, a subsidiary of the Burroughs Corporation, is one of the newer computer components that will help these goals to be realized. This new tube type is basically a highly versatile, high-speed, commutating and distributing device with the ability of providing, at each of its multipositions, an output to perform various functions such as the actuation of relays, and the operation of electronic gates. This paper will describe briefly this new device and will show various ways that it can be employed to perform basic computing functions.

78. Accuracy of a Binary Operational Multiplier

E. R. Beck

Data are presented on the accuracy of a binary operational multiplier whose two inputs are numbers represented by a set of single-weight pulses and a parallel

binary code and whose output is given by a second set of pulses. The operation of this device is analyzed, and a formula is derived for the output error as a function of the number of binary places in the multiplier and the number of input pulses. The error is calculated for normal operation of multipliers having up to nine places; from these data, formulas may be deduced for the average error and maximum possible error of an n-place multiplier. It is found that errors of greater than one pulse are possible, the maximum possible error increasing approximately linearly with the size of the multiplier. The constant of proportionality is less than one, however, so that the output error may be reduced below any given tolerance by use of a sufficiently large number of places in the multiplier. Two types of preset operation are also considered.

79. Arithmetic Features of New NBS Computers

J. L. Smith and A. Weinberger

The megacycle circuitry used in SEAC and DYSEAC can be organized logically to do arithmetic about 100 times faster than it is done in these NBS serial computers. In a proposed new NBS parallel computer, a fully parallel adder using a novel carry-anticipation scheme is used to obtain a basic addition cycle of one microsecond for a 53-bit word. This arithmetic unit is intended to operate in conjunction with a fully parallel memory having an access time of one microsecond. An alternative design suitable for use with a slower memory (access time of 4 to 12 microseconds) employs a serial-parallel organization and is about 18 times faster than SEAC. A special whiffletree multiplier permits certain complex operations such as high-speed radix conversions to be performed automatically.

80. Minimizing the Number of Operations in High-Speed Computing of Elementary Functions

E. G. Kogbetliantz

It is relatively easy to compute an elementary function to six decimals but if the desired accuracy demands that both relative and absolute errors be less in absolute value than 5.10^{-11} the choice of method becomes important, if one wishes to minimize the number of operations involved. Assuming that the easily accessible part of a machine's memory can accommodate the precomputed constants used in the subroutines, various methods are studied and applied to the shortest computation of elementary functions e^x, Log.x, direct and inverse trigonometric and hyperbolic functions, Bessel functions J_n, I_n, etc. Polynomial and rational approximations are found, using Darboux generalization of Taylor's Formula, continued fractions and Chebyshev expansions in series of orthogonal polynomials $T_n(x)$. These approximations allow the computation of elementary functions with an accuracy of $1/2.10^{-m}$ in the whole range of independent variables with the aid of a comparatively small number of operations.

81. Automatic Computations with Power Series

Peter Henrici

A code, designed for SEAC, is described that automatizes certain formal operations with power series. In order to avoid round-off difficulties and to obtain mathematically correct results, the coefficients in the power series are assumed to be rationals and all arithmetic operations are performed in the field of rational numbers. The following operations have been coded and tested: (a) raising a power series to an arbitrary, rational (but not necessarily integral or positive) power; (b) reversing a power series of the form $y = x^{\alpha}(1 + a_1x + a_2x^2 + \ldots)$, where α is rational and $\neq 0$. Problem (a) is solved by an algorithm communicated by J. C. P. Miller. The code for (b) is based on the Lagrange-Bürmann formula and uses the code for (a) as a subroutine. Applications (with numerical results) to combinatorial analysis, asymptotic expansions, and differential equations are considered.

82. Polynomial Relaxation Coefficients

R. W. Bemer

Tables are presented for use in either reducing the number of digits in polynomial coefficients or eliminating entire terms. These tables apply for the two ranges of argument (O to +L) and (−L to +L). A third table indicates resultant reduction of accuracy. Specific usages are: (1) reduction of calculation time and digit storage for computers; (2) distribution of error over lower order terms, in contrast to truncation, often resulting in elimination of an additional term within accuracy limits; and, (3) bivariate approximation of surfaces by polynomials whose coefficients are polynomials in a second variable. Examples of actual practice of the art are given, together with several immediately useful examples obtained by this method.

83. Rational Approximations of Functions

Bengt Carlson and Max Goldstein

Rational approximations of the type derived by Cecil Hastings, Jr., formerly of the Rand Corporation, have been found to be extremely useful in numerical work. A difference method especially suited for high-speed computation has been developed for obtaining such continued products (polynomials) and continued fractions. A code for the IBM Type 701 calculator, incorporating this method, is now available that rapidly and automatically computes the optimum approximation for an arbitrary degree n. To date, polynomial and continued fractions have been obtained for the elementary functions from n=2 to n, which makes the maximum error less than $5x10^{-8}$

84. An Experiment in Universal Coding

Saul Gorn

A 'Universal Code' is a pseudo-code common to a large class of different types of general-purpose, automatic, high-speed, digital computing machines. A plan for a simplified, semi-automatic, universal coding system was previously described by the author (Symposium on Automatic Programming for Digital Computers sponsored by the Office of Naval Research in Washington, D. C. on 13-14 May 1954). This paper presents the results to date of an experiment with this system run on both EDVAC and ORDVAC at Aberdeen. This experiment involved, beside the test problems, two executive routines for each machine and one executive routine in universal code which each machine translated into its own code. The input-output form used was punched cards. Actual time and storage figures are given.

87. A Truth Function Evaluator

William Miehle

This truth function evaluator automatically evaluates a truth function for any or all combinations of values of up to ten variables. The formula, expressed in Polish notation, is plugged and scanned by a stepping switch (ten symbols/sec) and may have a length of 98 and a rank of 6. Six common logical functions are evaluated directly: inclusive disjunction, exclusive disjunction, conjunction, implication, material equivalence, and negation. Several modes of operation are possible: manual, single evaluation, and continuous (stop at prescribed result of 0 or 1). In the continuous mode, the combinations are

automatically generated by a binary counter. The evaluator is essentially composed of one stepping switch and 40 relays. These are in the form of pluggable units mounted on a six-foot relay rack.

88. Digital Computer Arithmetic

James L. Maddox and Ralph H. Beter

A logical algebra that enables a logical designer to synthesize an efficient digital arithmetic section can be derived from the analysis of the arithmetic operations to be performed. This logical algebra, which uses expressions in conventional computer language, is based upon a logical rather than numerical interpretation of the symbols involved. The logical algebra to be described is concerned with binary arithmetic operations, but it is capable of extension to arithmetics of other number systems. The algebra is intended to be useful to digital computer engineers in general, and not exclusively to mathematicians. This logical algebra is an algebra in the true sense, being defined in terms of a scalar ring, a vector ring, and the necessary associated operations. An outstanding feature of this algebra is that it takes into account the sequencing of the basic steps that occur in an arithmetic operation.

89. Arithmetical Analysis of Logical Nets

Richard C. Jeffrey

A modification of ordinary arithmetic is proposed as a supplement to Boolean algebra in the analysis of digital networks. The sequence of bits at any terminal is interpreted as a number in binary notation, least significant digit first, "decimal" point last. Delay of one time unit has the effect of multiplying by two. Other details are analogous to those of elementary probability theory. For example, the logical sum is the arithmetical sum minus the number associated with the logical product, but in general no simple expression can be given for the logical product. The techniques are illustrated by the analysis of a number of logical feedback networks, including serial and parallel adders.

90. Remarks on the Gordon Research Conference

Max A. Woodbury

A session on Statistical Computation was held at the Gordon Research Conference in which a number of persons contributed papers concerning the application of large-scale computing machinery in statistical computations. These reports are summarized.

91. Generation of a Random Multivariate Normal Sample

Gene H. Golub

In this paper, a method for generating a random sample from a multivariate normal distribution, given the variance-covariance matrix, will be described. The problem is solved by getting a set of univariate normal deviates from a system of differential equations and then performing an orthogonal transformation. Some empirical results and their implications will be given.

92. Automatic, Many-Variate, Nonlinear Multiple Regression Analysis on a Large-Scale Computer

Arthur E. Hoerl

During the first six months of operation of the *du Pont Univac* computer, eleven large-scale multiple regression analyses have been completed. The largest study of this type included a seventeen-variate, fifty-term regression problem applied to process data collected during the past three years of a reactor operation. Analysis and interpretation of the regression equation indicated that fifty per cent of the observed variations in production were directly attributable to the process variables. Further studies were made relative to the individual variables to estimate their degree of effect on the reactor yield. As a result of this analysis, a more fundamental understanding of the interval-reactor mechanism has been realized, and, as an added reward, a significantly greater rate of production is now possible.

93. A General Curve Fitting Subroutine for Transcendental Functions

Robert H. Bracken

A ethod is presented to obtain a least squares fit to n points using a transcendental function having from zero to three linear parameters, zero to two nonlinear parameters, and one or two separate terms each containing the independent variable. The programming to compute each term in the function is all that is necessary before the method, which is written in subroutine form, can be used. The subroutine is easy to use and utilizes a searching technique for functions containing nonlinear parameters in which accurate guesses of the first estimates are not necessary. All sums of squares and cross products are computed in fixed-point, double precision arithmetic which ensures a high degree of sensitivity to a fit.

94. Filtering Sampled Functions

I. McNamee and E. D. Fullenwider

A method for use with a digital computer is given for filtering sampled functions of time. Each point of the output is the same linear combination of a suitably chosen number of points before and after the corresponding point of the input. The constants in the linear combination are those which minimize the rms magnitude of the difference between the desired and actual frequency-response functions. In contrast to network filters, arbitrary gain and, independently, arbitrary phase shift may be approximated as closely as desired in a frequency interval determined by the sampling rate. The spectral density of the input need not be known. Examples include equivalents of network filters and filters with frequency responses not realizable with passive networks.

95. Numerical Solution of a System of Parabolic Partial Differential Equations

H. Flatt

In R: $0 \leq t \leq T, -\infty < x < +\infty$, consider

$$\partial u/\partial t = A\,\partial^2 u/\partial x^2 + B\,v\,\exp(-C/u)$$

$$\partial v/\partial t = D\,\partial^2 v/\partial x^2 - E\,v\,\exp(-C/u)$$

subject to the initial conditions

$u(x,0) = f(x)$, $v(x,0) = g(x)$, $-\infty < x < +\infty$

where A, B, C, D, and E are given constants, and $f(x)$ and $g(x)$ are given functions. It will be shown that the stability criterion for this system of equations is the same as that for a single equation of the same type. Various analytical aspects of the problem are discussed, especially as they bear on the machine solution of the problem.

96. Pipe Stress Calculations on the Oracle

E. C. Long

A program for computing stresses in pipe lines of various configurations has been written for the Oracle. From a schematic diagram of the pipe layout, information is supplied to the code for each pipe segment as to plane, diameter, thickness, length (or bend radius), and direction. From these values coordinates, shape factors, matrices, and total combined stresses, including pressure stresses, are automatically computed for any number of segments. The code has been adapted to calculate lines with branches and deflections and rotations as required for pipe hanger calculations.

98. Transient Output and Race Conditions in Asynchronous Electronic Switching Circuits

David E. Muller

Combinational switching circuits which are parts of asynchronous circuits containing feedback must be constructed in such a way that no temporary or transient signals appear at the output as a result of legitimate changes of the inputs. A formula is given expressing the change in the output as a function of the input changes. Transient-free response is expressed as a mathematical restriction of this function, thus providing a convenient method for determining whether or not a given circuit has this property.

99. The Design and Use of Hazard-Free Switching Networks

D. A. Huffman

Networks of contacts are usually designed with the assumption that they behave ideally; that is, that make and break contacts on a given relay always have complementary transmissions. This assumption is valid as long as the relay is in a steady-state condition; it is not when the relay is in a transient state. When a multi-variable contact network is made up of contacts from several relays, the nonideal behavior of the various contacts can create what is known as a hazard. If a hazardous network is used to control a relay of a time-dependent circuit, improper operation may occur. A method is proposed in this paper by which network hazards may be eliminated without resort to accurate timing of the contacts on the individual relays. No new algebra is necessary in arriving at these design results. Counterparts of hazard-free contact network syntheses are found to exist for electronic (gate type) circuits. Examples are given of the use of hazard-free networks as components in relay and electronic sequential switching circuits.

100. Networks of Multipole Sequence Transducers

Manfred Kochen

A system, P_0, is regarded as an information network of multipole sequence transducers, $P_1, \ldots, P_N$. During the h^{th} period of quantized time, P_i is in state s_i^h and receives the output of $P_{i_1}, \ldots, P_{i_N}$; i.e. the input to P_i is $y_{i_1}^h, \ldots, y_{i_N}^h$. The behavior function of P_i is defined by:

$$y_i^{h+1} = f_i(s_i^h, y_{i_1}^h, \ldots, y_{i_N}^h)$$

$$s_i^{h+1} = g_i(s_i^h, y_{i_1}^h, \ldots, y_{i_N}^h)$$

Defining the state of P_0 by

$$s^h = (s_1^h, \ldots, s_N^h, y_1^h, \ldots, y_N^h)$$

the behavior of P_0 can be determined from the components' behavior functions by a method which is well suited to computer use. Results relating the cyclical nature of the system behavior to the types of behavior functions of the components, the network structure, and the initial conditions are obtained. A study of how the behavior of P_0, regarded as a mechanism, can be realized with specified components, is begun.

101. A General Least Squares-Differential Correction Curve Fitting Program

John O. Lilly

A general, curve-fitting program designed for high-speed computer use and its successful application to an aeroballistics problem is described. The fitting function may involve several independent variables; therefore, multiple regression analyses may be made with the program. A maximum of 21 parameters, which may enter the function linearly or nonlinearly, can be fitted for or held constant in any combination. A differential correction technique is employed; therefore, the user must supply initial values for the parameters and a subroutine to evaluate the function and its partial derivatives with respect to the parameters. Convergence is dependent entirely upon the particular function employed and the accuracy of the initial values of the parameters.

102. Statistical Computations Using the Census Univacs

James L. McPherson

The 1954 Censuses of Business and Manufacturers, the nation's monthly statistics on foreign trade, the monthly survey from which are derived the official government estimates of employment and unemployment are some of the projects currently being processed on the Census Bureau's electronic data-processing equipment. Various kinds of statistical computations relating to these projects have been programmed and are an integral part of the processing operations. These include examination of data as originally reported for internal consistency; measurement of sampling and other kinds of errors; and adjustment of sample data to universe totals. The Univac's ability to perform this work will be evaluated. Also the use of Univac for analyzing seasonal variations in time series will be described.

103. Use of the Electronic Digital Computer by the Statistical Laboratory

W. C. Jacob

In setting up the statistical laboratory in the Agronomy Department of the College of Agriculture the Illiac has been used as the basic computational device. The detailed procedure for processing data from the time the observations are recorded in the data book until the complete analysis is available will be presented. Examples of typical program results will be shown and some data pertaining to operational activities will be given. Experience has shown that few problems are not applicable to mechanical processing of data. The rapid availability of the results of research has broad implications with respect to efficiency and progress of research. Some of the direct effects noted in less than a year's time will be described.

104. Factorial Classification of Cerebral and Autonomic Reaction Patterns Used in the Differentiation of Physiological Age and Clinical Syndrome Groups

Christine Kris

Waveform analyses were carried out on 22 physiological indicators of cerebral and autonomic activity (E.E.G., G.S.R., E.K.G. and continuous blood pressure recordings) obtained simultaneously from the records of 171 patients ranging in age from 5 to 50 years, who were referred to the Psychophysiological laboratory (Director: Dr. C. W. Darrow) at the Institute for Juvenile Research, Chicago, with the aim of arriving at a differential diagnosis be-

tween organic and emotional behavior problem patients. Average measures of 3 ten second time samples were used. These measures and chronological age were punched into individual IBM cards and standard scores derived from their distributions. Then correlations were computed. To account for factors underlying complex interrelationships, principal axes were computed on Illiac, yielding a modified eigenvector solution which maximizes common variance components in hierarchical order. Individual factor measurements have also been obtained. The results and implications will be discussed.

105. A Study of the Validity of Multiple-Choice Test Items Using an Electronic Computer*

Jack C. Merwin

This is a report of the use of the ILLIAC in a mathematical study of factors affecting the validity of multiple-choice items. In this study the probability of choice of each alternative in any given item was needed. These probabilities were obtained through a model requiring the integration of certain portions of the normal bivariate distribution for each set of data used. A wide range of hypothetical data was used and two nomograms were developed for obtaining the desired probabilities. Validity estimates were calculated for each item under four different scoring schemes. These validities were used to draw generalizations about how the selection of alternatives, testing procedure and scoring scheme affect the validity of three-choice items.

*Based on the writer's dissertation submitted for the Ed. D. at the University of Illinois, 1955.

106. Codes for the Membrane Problem

C. L. Gerberich and W. C. Sangren

A classical membrane problem, where $\nabla^2 \phi + \lambda^2 \phi = 0$ and $\phi = 0$ on the boundary, also appears in nuclear reactor theory. A general code was written which, by an accelerated iterative technique, approximates the associated fundamental eigenvalue λ^2 and eigenfunction ϕ. The boundary is specified as an input to the code and is assumed to lie on mesh points. Three additional codes were used. One code finds equi-value contours for the eigenfunctions. Another code uses the iterated function to obtain an additional estimate of the eigenvalue through a calculus of variation definition. The remaining code fits eigenvalues as a function of mesh size. Results have been obtained for membranes in the shape of L's, T's, crosses and square doughnuts.

107. On the Use of NORC for Solving Free Boundary Problems in Hydrodynamics

R. J. Arms, D. F. Eliezer, L. D. Gates, Jr., and D. M. Young, Jr.

Determining the axially symmetric cavitational flow of an ideal fluid past a pair of disks involves the solution of a boundary value problem with an elliptic differential equation, where the location of part of the boundary is to be determined by specifying there the additional condition of constant velocity. The computational procedure used with the NORC was to estimate a trial "free" boundary, solve a difference equation for 1145 interior points by iteration, modify the free boundary, and repeat until the velocity was constant. After 12 trials the velocity was uniform to within $\pm 1\frac{1}{2}\%$. For greater accuracy an expansion was used near the separation point. A correction was made for the "wall effect" due to the introduction of artificial boundaries.

108. A Two-Dimensional Reactor Calculation

Elizabeth Cuthill and Ruth M. Davis

Given a system of n elliptic partial differential equations of the form

$$\nabla D_i \nabla d_i - A_i d_i + B_i d_{i-1} = 0 \qquad i = 2,3,\ldots,n$$
$$\nabla D_i \nabla d_i - A_i d_i + \eta B_n d_n = 0 \qquad (1)$$

with mixed, homogeneous boundary conditions in a connected, two-dimensional region where the A_i, B_i, and D_i, are piecewise continuous and such that $D_i > 0$, $A_i > 0$, $B_i \geq 0$, the problem is to determine numerically the minimum eigenvalue of the system and the corresponding eigenvector. In order to avoid the difficulties, while still obtaining the advantages, which result from allowing a variable mesh, the technique of permitting flexible boundaries and retaining a uniform mesh is explored. To do this the region is covered by a uniform mesh of not more than 58 x 118 points. The solution is computed at each of these by the linear iterative method of successive overrelaxation that was developed by D. Young for solving the Dirichlet problem numerically and which is here extended and applied to the solution of (1).

109. Computation of Components for Logarithmic Networks on a High-Speed Digital Computer

Robert C. Miller, Jr. and Dr. Ralph G. Selfridge

The use of logarithmic networks in analogue computers is known to be feasible (e.g., see AIEE Paper No. 54-389) and, in some respects, quite desirable. Production of these resistor-diode networks presents problems such as component tolerances, number of diodes to use, effect of temperature changes, etc. To collect the data needed to answer these questions, computations were performed on the IBM 701. These computations included resistor values, maximum input current, and error plots of the networks. This paper presents a statement of the problem and the numerical processes developed to obtain the solution. A discussion as to how the computations helped answer some of the engineering problems is included.

110. The Computer as the Center of the Corporate Accounting Function

W. M. Harris

(1) A description of the manner in which data from the various source documents is brought into the computer system and a brief description of the basic accounting applications. (2) Types of reports prepared and the examples of retention of summary data for future reports and records. (3) A description of the way in which each basic application relates to the others and the use of the computer system to integrate the various applications. (4) Requirements of computer accounting: A. uniformity; B. volume; C. planning; and, D. separation of judgment and nonjudgment operations. (5) Methods of achieving above requirements. (6) Changes required in most accounting departments: A. consistency of method; B. elimination of human intervention at intermediate steps in the processing; and, C. accountants must have imagination in use of equipment to handle their problems in the same manner that equipment has been used in the factory. (7) Changes in the accountant's position as a result of use of a computer.

111. Extrapolation of Classified Sales Data

P. A. Zaphyr

A company's sales for a certain year can be represented in table form, classified by products and regions. It is desired to estimate the corresponding sales table for the total market so that the row and column sums agree with those obtained from industry compiling agencies. The problem is formulated statistically by means of the Maximum Likelihood Principle, which gives the estimates as the solution of a non-linear programming problem of relatively simple form. The constraints are all linear but

the function to be maximized is a linear combination of the logarithms of the unknowns. A solution is obtained using successive quadratic approximations to the non-linear function. The results of a sample case, processed by a medium-sized, digital calculator, are discussed.

112. Payroll Systems on Univac

Stephen E. Wright

Payrolls are now being computed on three UNIVAC systems and the programming is in an advanced stage on several more. This makes possible a comparative study of several factors in business applications of computers. Some of the significant factors that will be discussed are: impact on past procedures, internal audits and controls, centralized operations, selection and training of personnel, division of responsibility in procedures and operation, employee relations, exchange of information among different groups, and problems of installation and operation. The study indicates that while there is little hope that new installations can use programs developed in a previous installation, the accumulated experience in system analysis, organization, and administration is invaluable.

113. Mathematical Programming in Sales and Marketing

Nyles V. Reinfeld

Certain market research problems such as locating retail outlets and sales forecasting are solved by correlation techniques. Mathematical programming has been used for these types of problems, and permits the handling of a large number of variables and data. Problems such as these cannot be solved by approximations for precise answers are desired. The time element, however, is not usually critical, so that these problems can be set up for punched-card or digital equipment. Other problems of this same nature are: salary evaluation, advertising evaluation, and furnace-charge schedules.

114. An Application of a Digital Computer to Numerical Control

Arnold Siegel

The MIT Numerically-Controlled Milling Machine is a machine tool that is automatically controlled by instructions punched in a paper tape. A complicated sequence of cutter motions may be specified in speed and direction by these instructions, with no human intervention required during the cutting. The punched instructions are in numerical form. This requires that the x, y, and z coordinates of the significant points on the work be computed. The path of the cutter center (which is not the same as the path being cut) must then be obtained from these coordinates and the resulting numbers converted to octal for punching. This procedure, even for a relatively simple cutting job, is tedious and subject to mistakes. An experimental Whirlwind I routine for the preparation of NCMM control tapes is described. The user of this routine need have no knowledge of the digital computer itself and need do only a minimum of computation. The routine accepts as input a symbolic description of the problem, interprets the description, determines and executes the necessary calculations, and finally punches the required control tape.

115. A Study of the Effect of Digitalization on the Performance of a Feedback Control System

R. E. Spero and J. Stuart

When a digital computer is used in an otherwise stable, feedback-control system, the sampling and delay characteristic of this type of computation may cause large transients or even instability in the system. This paper describes a simulation study of the effect of a digital computer on an aircraft-heading control loop. The equipment used, which consisted of a d-c differential analyzer and a relay circuit for sampling and holding the data, is described. Traces showing the effect of the computer on the transient responses are presented, and the use of rate data to compensate for the computer action is demonstrated. The advantages and limitations of this method for analyzing mixed control loops are discussed.

116. A Comparison of an Analog and a High-Speed Digital Solution to a Fuel Tank Heating Problem

J. K. Slap

A multi-dimensional heat-transfer problem was solved on both a high speed digital computer and an electronic analog computer. The problem involved calculation of transient and steady-state temperature distributions in an aircraft internal fuel tank and its surrounding structural members. The digital solution was obtained on an IBM Type X-795 Electronic Calculator, and the analog on a REAC Model C102. The practical and philosophical differences in approach between the analog and digital solutions are discussed. In addition, a comparison is made of programming, checking, and running times involved. Also compared are numerical results obtained from the two methods of solution. Finally, certain pertinent remarks concerning programming and checking techniques used with the IBM Type X-795 Electronic Calculator are included.

117. Solution of Large Problems on the REAC®

A. Karen and B. Loveman

Three problems, each requiring approximately 200 amplifiers, have been programmed and run successfully at Project Cyclone. The subject matter of this paper consists of a brief description of the problems and their solution. Solutions obtained on the REAC have been compared with digital solutions obtained in one case on the IBM CPC and in the other two on the Elecom 100 located at Project Cyclone. The analog solutions are in excellent agreement with digital checks. A discussion of analog techniques for coordinate transformations in three dimensions will be presented. Some special circuit problems encountered in programming will be mentioned.

118. On the Propagation of Errors in the Digital Evaluation of Convergents to Continued Fractions

Nathaniel Macon

The purpose of this paper is to obtain estimates for the error incurred in the digital evaluation of a continued fraction. It is shown that this error can be expressed as a continued fraction which, in turn, yields sharp and relatively simple error bounds. As a further consequence, one is able to select scale factors in advance so as to optimize the results. Recent computational experience with these methods is discussed. For many standard, frequently-used functions a significant reduction in computation time has been achieved over other methods yielding comparable accuracy.

119. Programming a Restricted Random Walk

R. S. Lehman and G. H. Weiss

High polymer molecules are often studied by means of restricted random walks. Approximate analytical treatments shed little light on important features of the most relevant restricted walks, those in which the walker never

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Forum

THE ADVANCE OF AUTOMATION

F. Palmer Weber,
New York, N. Y.

A visitor's quick impressions of the Chicago Machine Tool & Production Engineering shows may interest your readers:

(1) Almost all 500 machines on exhibit were automatic. Assembly lines composed of these machines will in the future pace the worker rather than the worker pacing the machines.

(2) On the average, the new machines are 25% more productive than similar machine tools ten years of age and older; in many cases, the increase is 50 to 100%.

(3) About 50% of all existing tools are ten years of age or older. This factor is operating combined with new tax depreciation methods, higher wages, more competitive markets requiring cost reductions, the yearly introduction of "fashion" in durable consumer goods, and the defense requirements. As a result, all of these factors combined are giving a steadier base to the entire machine tool industry.

(4) The electrical, electronic, and instrument industries are now permanently integrated with tool development. In brief, the second industrial revolution is in sustained stride.

It would appear that the largest corporations with adequate capital will make immense strides in automated assembly lines and in cost reductions in the next five years.

The smaller, interstitial firms will probably pursue the path of gadgetry: the use of reconditioned machines equipped with as much automatic control equipment as possible.

In both cases, the market for automation devices will be sustained.

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revisits the same point. Machine studies of this type of walk on a two-dimensional lattice are being made on ORDVAC. The walks are made on a section of the memory of the machine, each binary-digital position corresponding to one lattice point. This method is faster than an explicit coordinate - storage scheme and allows the printing of a picture of the walk.

120. Statistical Study of Nonintersecting Random Walks

W. F. Atchison, F. T. Wall and L. A. Hiller, Jr.

Non-intersecting random walks were studied for various lattice structures in two, three, and four dimensions. A statistical determination for the mean square length, $\bar{r}$, of all walks of a given number of steps, n, was made on the ILLIAC. This was done over a large range of values for n. The $\lim_{n \to \infty} \frac{\bar{r}}{n}$ was also studied since it is of importance to chemists, especially in their studies of polymer molecules. A difference equation, coupled with machine results, predicted that for the lattices first studied the ratio in question diverges in two dimensions, converges in four dimensions, and appears to converge in three dimensions. Recent work indicates that convergence or divergence is not necessarily determined by the dimension alone.

121. The Computation of Energy Levels in a One Dimensional Crystal Lattice

J. Gardner, R. Page and O. L. Tiffany

A square-well model was set up on MIDAC using the method of James and Ginzbarg, to compute the energy levels in a disordered, one-dimensional crystal lattice. Parameters were so chosen as to simulate an InSb crystal. A Monte Carlo technique was used to introduce excess In or Sb and/or crystal disorder into the lattice. Matrix multiplications determined the phase advance of a Schroedinger wave in the crystal. A node count of the wave gave the number of energy levels below the value chosen for the energy parameter. Based on the MIDAC calculations, energy gaps were obtained for disordered and nonstoichiometric InSb. The behavior of energy levels near the edges of the energy gap gives a measure of mobility of holes and electrons as well. The results from this simplified theory agreed surprisingly well with experiments.

122. Programming for a Production Operation

R. E. Utman and Margaret H. Harper

The Aviation Supply Office in Philadelphia is responsible for the distribution and replenishment of all aeronautical parts for the U. S. Navy. To aid in this mission, an IBM-701 was installed in February 1954, and an IBM-702 arrived in May 1955 to replace it. A staff of 40-50 people is programming and operating for the three shifts required to handle the approximately 5 million card records of information quarterly. Production experience gained on the 701, which required that each of 21 classes of stock be processed through 63 different machine runs each quarter, has caused major changes in programming policy and standards. File identification, tape labeling, operating logs, restart procedures, and other "housekeeping" requirements as they have affected programming and operations, will be discussed.

123. The Mechanization of Stock Transfer

Anthony G. Oettinger

One important function performed by many banks is that of transfer agent for corporations. The chief duties of the transfer agent are the maintenance of up-to-date records of the ownership of the shares of client corporations, the proper cancellation and issuing of stock certificates when transfers take place, and the payment of dividends. Auxiliary duties include the sending of meeting notices, the handling of proxies, the preparation of tax reports, and other occasional services. The performance of these duties is mainly a matter of clerical routine. It is the purpose of this paper to consider the extent to which this routine might be profitably mechanized, and to specify what type of automatic equipment is needed best to serve that purpose.

124. Application of Electronic Data Processors in Shop Loading

W. F. Bauer and A. Vazsonyi

One of the most vexing problems in manufacturing is that of developing shop loading techniques which yield schedules that can be realized with available machines. The paper will describe a mathematical model concerning the scheduling of the machines of a job shop. A solution to this problem will be developed which automatically assures that the schedule will be within available capacities. The nature and magnitude of the data-processing requirements will be analyzed and data-processor characteristics suitable to meet these requirements will be given. Hypothetical and specific data-processors will be discussed with regard to storage requirements and time for solution.

125. Application of an Electronic Data Processing Machine to Inventory Control

R. P. Beals

Of all the industrial applications of computers, inventory control shows promise of being one of the most rewarding. This paper describes how an automotive parts division will apply an IBM Type 702 Electronic Data-Processing Machine to assist in the control of its parts inventory. The 702 appears to have met the challenge of controlling some 60,000 automotive replacement parts at seven warehouses variously located in the United States. The paper will discuss the development of administrative procedures and their translation to computer programs to attain a highly efficient inventory control system. The system encompasses the areas of commitment control, stock accounting, back order control, invoicing, and cost of sales reporting.

126. Automatic Function Recording and Play-back in an Electronic Analog Computer

Louis B. Wadel and B. B. Mackey

Conventional electronic analog computer components can be used to record a time-dependent function as it is generated in the computer, and to playback a function so recorded. The function is recorded as a set of its values at discrete instants of time; interpolation formulas can be mechanized to play back the function as a smooth approximation to the original function recorded. Each point recorded is represented by a voltage stored on the feedback-capacitor of an integrator; a timing device is required for selective actuation of the storage integrators. As an example, the static deflection of a loaded cantilever beam, governed by a differential equation with split boundary conditions, is calculated automatically.

127. Hitachi Electronic Analog Computers and Their Applications

Takeo Miura and Toshiro Numakura

Repetitive analog computers have been studied and developed for the last few years at Hitachi Central Research Laboratory. They are used for computations in various fields, such as servomechanism designs or mathematical

analyses of nonlinear oscillations. Hitachi Electronic Analog Computers consist of three standard racks, containing 36 operational amplifiers as linear elements, two multipliers, four arbitrary function generators and three limiters as nonlinear elements, and a cathode-ray oscillograph for indicating solutions. To observe solutions, a seven inch oscillograph is used and the measurements are made by a vacuum-tube voltmeter and an electronic time marker. The impedances for the desired transfer functions are self-contained in each of 36 operational amplifiers, 12 of which are designed to be set by selecting 20 push buttons, respectively. The multipliers are based on quarter-square method using a triangular wave, whose frequency is about 160 kc.

128. Transfer Function Simulation by Means of Amplifiers and Potentiometers

L. E. Heizer

A method is presented for synthesizing any given transfer function by means of standard computing amplifiers (summers and integrators) and potentiometers. Advantages of this method include: (1) easy control is maintained over natural frequencies, damping ratios and time constants; (2) accelerations, rates and positions of servo and other type systems may easily be limited; and (3) no passive networks are required. Computer circuits composed of the least number of components have been catalogued to simulate the transfer function of any three-terminal R-C network having 2, 3, 4 or 5 elements and any second-order system. Combinations of these circuits may be used to simulate any transfer function. Each circuit is supplemented with its transfer function, Bode plot, and gain relations.

129. A Method for Solving Boundary Value Problems on an Electronic Analog Computer

M. Yanowitch

This paper describes a method for solving linear boundary value and eigenvalue problems for ordinary differential equations on an electronic analog computer. It has been employed to compute the first four frequencies and modes for a sixth-order system of differential equations representing the coupled (bending-torsion) vibrations of a beam. The frequencies were accurate to better than 0.3%. The computer generates all the linearly independent solutions which satisfy the boundary conditions at one end point. A determinant of the appropriate values of these solutions at the other end point is used to obtain the solution to a boundary value problem, or to determine how to vary the parameter in order to obtain an eigenvalue.

– END –

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W. L. Mandel,	P. O. Box 29, New York 10, N. Y.
M. S. Weinstein,	83 Melrose Ave., Albany 3, N. Y.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

Name	Address
none	

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.) ***

Edmund Callis Berkeley
(Signature of editor, publisher, business manager, or owner)

Sworn to and subscribed before me this 22 day of September, 19..

[SEAL]

Jean L. Kampen

(My commission expires [redacted])

POD Form 3526 (Mar. 1955) 10—18730-7

NEW PATENTS

RAYMOND R. SKOLNICK, REG. PATENT AGENT
Ford Instrument Co., Div. of Sperry Rand Corp.,
Long Island City, N.Y

The following is a compilation of patents pertaining to computers and associated equipment from the Official Gazette of the United States Patent Office, dates of issue as indicated. Each entry consists of: patent number / inventor(s) / assignee / invention.

May 17, 1955: 2,708,718 / Leon H. Weiss, Beverly Hills, Calif. / Hughes Aircraft Co. / A phase detector network.

2,708,720 / Alva Eugene Anderson, Mountainside, N. J. / Bell Telephone Laboratories, Inc. / A transistor trigger circuit.

2,708,722 / An Wang, Cambridge, Mass. / - / A pulse transfer controlling device.

2,708,738 / Jarrett L. Hathaway, Manhasset, N. Y. / United States of America / A pulse producing system.

May 24, 1955: 2,709,239 / George Briggs, London, England / B.V.C. Electronic Developments Limited / A phase shifting network for shifting the phase of an alternating current flowing in a second circuit relative to a phase of an alternating current flowing in a first circuit.

May 31, 1955: 2,709,303 / Edmund B. Hammond, Jr., Albertson, N. Y. / The Sperry Corp. / A lead angle computer for gun sights.

2,709,746 / Fountain T. Page, Baltimore, Md./ Westinghouse Electric Corp. / A system for generating rectangular pulses of voltage.

2,709,747 / Bernard M. Gordon and Herman Lukoff, Philadelphia, Pa. / Remington Rand Inc. / An impulse generating apparatus.

2,709,757 / William E. Triest, Hyde Park, N. Y. / International Business Machines Corp. / An alternating current circuit element having a linear impedance element in series with a circuit network.

2,709,771 / Joseph W. Dehn, Great Neck, N.Y./ Bell Telephone Laboratories, Inc. / A pulse counting and registration system.

June 7, 1955: 2,710,361 / Albert M. Skellett, Madison, N. J. / National Union Radio Corp./ A binary coding and decoding tube of the cathode ray type.

2,710,362 / Robert M. Ashby, Pasadena, Calif./ United States of America / An electronic analog computer.

June 14, 1955: 2,710,720 / Ralph B. Blackman, Cranford, N. J. and Hendrik W. Bode, New York, N. Y. / Bell Telephone Laboratories, Inc. / An artillery computer.

2,710,721 / Amasa S. Bishop, Cambridge, Mass./ United States of America / An electronic dividing circuit.

2,710,722 / Marcel E. Droz, Cambridge, Mass., Raymond L. Garman, Flushing, N. Y., and Robert U. Nathe, Minneapolis, Minn. / United States of America / Apparatus for computing the error distance from interception between first and second moving bodies.

2,710,723 / Leroy A. Nettleton, Ridgewood, N. J., and Carlton W. Miller, Boston, Mass./ United States of America / A mechanical electrical computing circuit for solving a fuse setting equation.

2,710,915 / Gregory O. Young, Hawthorne, Calif. / Hughes Aircraft Co. / An electronic integrating network.

2,710,962 / Edgar H. Fritze, Cedar Rapids, Iowa / Collins Radio Co. / A punch card controlled aircraft navigation computer for computing the distance and direction from a craft to an arbitrarily chosen waypoint.

June 21, 1955: 2,711,290 / Robert P. Haviland, Scotia, N. Y. / General Electric Co. / An electromechanical multiplier for computing devices.

2,711,443 / Robert Gaston Blondé, Paris, France/ Société Alsacienne des Constructions Méchaniques / An electrical transmission system in which an intelligence wave is sampled for its instantaneous amplitude at periodically recurring time instants and in which the successively sampled amplitudes are represented by recurring coded pulse groups.

2,711,478 / Guenther H. Krawinkel, Frankfort am Main Eschersheim, Germany / - / An arrangement for storing electrical signals and transferring the stored signals into a different circuit.

2,711,499 / Bernard Lippel, Red Bank, N. J. / United States of America / A digital servo system for periodically encoding and serially transmitting in separate channels input and output analog data as digital pulse code group signals, each in cyclic binary code.

June 28, 1955: 2,711,856 / John W. Gray and Duncan MacRae, Jr., Cambridge, Mass./ United States of America / A bombing computer

2,712,065 / Robert D. Elbourn, Washington, D. C., and Ralph J. Slutz, Kensington, Md./ United States of America / Gate circuitry for electronic computers.

BULK SUBSCRIPTION RATES

These rates apply to subscriptions coming in together direct to the publisher. For example, if 5 subscriptions come in together, the saving on each one-year subscription will be 25 percent, and on each two-year subscription will be 33 percent. The bulk subscription rates, depending on the number of simultaneous subscriptions received, follow:

Table 1 -- Bulk Subscription Rates
(United States)

Number of Simultaneous Subscriptions	Rate for Each Subscription, and Resulting Saving to Subscriber. One Year	Two Year
10 or more	$3.00, 33%	$5.40, 40%
5 to 9	3.33, 25	6.00, 33
4	3.75, 17	7.00, 22
3	4.00, 11	7.50, 17
2	4.25, 5	8.00, 11

For Canada, add 50 cents for each year; outside of the United States and Canada, add $1.00 for each year.

SPECIAL ISSUES OF "COMPUTERS AND AUTOMATION"

The issue of "Computers and Automation" in June, 1955, was a special issue: "The Computer Directory, 1955", 164 pages, containing: Part 1, Who's Who in the Computer Field; Part 2, Roster of Organizations in the Computer Field; and Part 3, The Computer Field: Products and Services for Sale. It is expected that the next Computer Directory issue will be June, 1956.

The next two special issues will be December, 1955, and January, 1956. The December issue will be mainly devoted to useful information for people who have been in the computer field for some time: a "Glossary of Terms", and also cumulative editions of other pieces of reference information.

The January, 1956, issue will be mainly devoted to useful information for people who have newly entered the computer field: an introduction to computers (and to "Computers and Automation"); and reprints and revisions of some of the more introductory articles and papers that "Computers and Automation" has published.

FORUM

SUPERVISION OF HUMAN OPERATORS

Bill Danch
Munich, Germany

Mr. Slepian, even if it is the night shift, it would be appreciated if you would attend to your duties. At 2:09 A. M. you did not load my tape reel No. 8.

MANUSCRIPTS

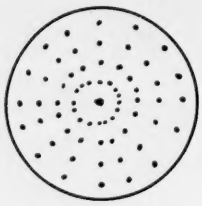
We are interested in articles, papers, and fiction relating to computers and automation. To be considered for any particular issue, the manuscript should be in our hands by the fifth of the preceding month.

Articles. We desire to publish articles that are factual, useful, understandable, and interesting to many kinds of people engaged in one part or another of the field of computers and automation. In this audience are many people who have expert knowledge of some part of the field, but who are laymen in other parts of it. Consequently a writer should seek to explain his subject, and show its context and significance. He should define unfamiliar terms, or use them in a way that makes their meaning unmistakable. He should identify unfamiliar persons with a few words. He should use examples, details, comparisons, analogies, etc., whenever they may help readers to understand a difficult point. He should give data supporting his argument and evidence for his assertions. We look particularly for articles that explore ideas in the field of computers and automation, and their applications and implications. An article may certainly be controversial if the subject is discussed reasonably. Ordinarily, the length should be 1000 to 4000 words, and payment will be, generally, $10 to $40 on publication. A suggestion for an article should be submitted to us before too much work is done.

Technical Papers. Many of the foregoing requirements for articles do not necessarily apply to technical papers. Undefined technical terms, unfamiliar assumptions, mathematics, circuit diagrams, etc., may be entirely appropriate. Topics interesting probably to only a few people are acceptable. Payments will be made for papers, generally $5 to $20 on publication, depending on length, etc.

(continued on page 39)

ARE YOU LOOKING FOR A CHRISTMAS PRESENT FOR AN INTELLIGENT BOY OR A BRIGHT YOUNG MAN INTERESTED IN COMPUTERS?



G E N I A C

Electric Brain Construction Kit

With this kit you can make over 30 small electric brain machines that compute arithmetically, solve puzzles, play games, reason logically, handle ciphers, and exhibit intelligent behavior. The kit contains over 400 parts, including six multiple switches of a new design, and a 64-page manual with simple and complete instructions. Each machine operates on one flashlight battery; all connections with nuts and bolts, no soldering required. This kit is the outcome of five years of design and development work with small robots by Berkeley Enterprises, Inc., publishers of "Computers and Automation". It is simple enough for intelligent boys, yet instructive to anyone because it exhibits the amazing capacities of computing and reasoning circuits.

MONEY BACK GUARANTEE: Returnable in seven days (if in good condition) for full refund, if not satisfactory.

SOME OF THE SIMPLE ELECTRIC BRAIN MACHINES THAT YOU CAN MAKE WITH THE GENIAC KIT

Logic Machines
- Comparing
- Reasoning
- Syllogism Machine
- Intelligence Testing

Cryptographic Machines
- Secret Coder
- Secret Decoder
- Combination Locks

Game Playing Machines
- Tit-Tat-Toe
- Nim

Arithmetic Machines
(Decimal and Binary)
- Adding Machine
- Subtracting Machine
- Multiplying Machine
- Dividing Machine
- Arithmetical Carrying
- Binary-Decimal Converters

Simple Circuits
- Burglar Alarm
- Automatic Oil Furnace Circuit, etc.

Puzzle Machines
- The Space Ship Airlock
- The Fox, Hen, Corn, and Hired Man
- Douglas Macdonald's Will
- The Uranium Shipment and the Space Pirates
- The Two Jealous Wives

PARTS LIST:

1 64-page Manual (written by Edmund C. Berkeley)
6 Multiple Switches of a new design
1 Mounting Panel
1 Flashlight Battery
1 Battery Clamp
10 Flashlight Bulbs
10 Bulb Sockets
50 Feet of Insulated Wire
Nuts, Bolts, Jumpers, and other necessary hardware

(NO SOLDERING REQUIRED -- COMPLETELY SAFE --

SCIENTIFIC -- ENTERTAINING -- INSTRUCTIVE)

----------Mail this Request or a Copy of It----------

Berkeley Enterprises, Inc.
36 West 11 St., R132, New York 11, N. Y.

Please send me the Geniac Kit. I enclose in full payment: ( ) $19.95, U. S. east of Mississippi; ( ) $20.95, elsewhere in U. S.; ( ) $21.95, outside of U. S. (If in good condition, it is returnable in seven days for full refund.) My name and address are attached.

CORRECTION

In the August issue, in the article "Charting on Automatic Data Processing Systems", by H. Eisenpress, J.L. McPherson and J. Shiskin, on page 21, the third paragraph should read as follows:

The printing tape is then prepared on the Univac line by line. On each line a symbol is positioned in the space corresponding to the y value for that month, and the remainder of the line is left blank. For example, for March 1955, the converted value, i.e., y for farm income in unadjusted form is 40; the seasonally-adjusted figure for the same month, again in y units, is 59. Therefore, for March 1955, the chart shows an "0" in space 40, an "X" in space 59, and no other entries on that line. (The selection of "0" and "X" to represent the two series plotted is arbitrary; any other symbols from among the 51 available on the high-speed printer could be used.) Where the "X" and "0" coincide on the chart, only the "X" is shown since it is not possible to overprint on the printer automatically. It would, of course, be possible to choose a third symbol to be printed in such cases of coincidence.

* ——————————— *

MANUSCRIPTS
(continued from page 37)

Fiction. We desire to print or reprint fiction which explores scientific ideas and possibilities about computing machinery, robots, cybernetics, automation, etc., and their implications, and which at the same time is a good story. Ordinarily, the length should be 1000 to 4000 words, and payment will be, generally, $10 to $40 on publication if not previously published, and half that if previously published.

- END -

ROSTER ENTRY FORMS

"Computers and Automation" publishes from time to time reference information of the following three types: (1) a who's who or roster of individuals interested in the computer field; (2) a roster of organizations active in the computer field; and (3) a classified directory or roster of products and services offered in the computer field. The last cumulative roster appeared in "The Computer Directory, 1955", the June 1955 issue of "Computers and Automation." If you are interested in sending information to us for these rosters and their supplements, following is the form of entry for each of these three rosters. To avoid tearing the magazine, the form may be copied on any sheet of paper; or upon request we will send you forms for entries.

(1) Who's Who Entry Form

1. Name (please print)_____
2. Your Address? _____
3. Your Organization? _____
4. Its Address? _____
5. Your Title? _____
6. YOUR MAIN COMPUTER INTERESTS?

( ) Applications
( ) Business
( ) Construction
( ) Design
( ) Electronics
( ) Logic
( ) Mathematics
( ) Programming
( ) Sales
( ) Other (specify): _____

7. Year of birth? _____
8. College or last school? _____
9. Year entered the computer field? _____
10. Occupation? _____
11. Anything else? (publications, distinctions, etc.) _____

(2) Organization Entry Form

1. Your organization's name? _____
2. Address? _____
3. Telephone number? _____
4. Types of computing machinery or components, or computer-field products and services that you are interested in?

_____

_____

5. Types of activity that you engage in:
( ) research
( ) manufacturing
( ) selling
( ) consulting
( ) other (please explain): _____
6. Approximate number of your employees? _____
7. Year when you were established? _____
8. Any comments? _____

Filled in by _____

Title _____ Date _____

* ——— * ——— *

(3) Product Entry Form

1. Name or identification of product (or service)?
2. Brief description (20 to 40 words)? _____
3. How is it used? _____
4. What is the price range? _____
5. Under what headings should it be listed?
6. Your organization's name? _____
7. Address? _____

Filled in by _____

Title _____ Date _____

specify BOBBIN CORES by ARNOLD

Ultra-thin tape for bobbin cores is rolled to high precision standards for thickness and finish on our own 20-high Sendzimir cold reducing mill, beta-ray controlled.

Write for **BULLETIN TC-108**

"TAPE-WOUND BOBBIN CORES FOR COMPUTER APPLICATIONS"

Includes essential data on applications and properties, fabrication and testing of Arnold Bobbin Cores; lists standard sizes, etc.

ADDRESS DEPT. 00-00

These cores, fabricated by winding ultra-thin tape of high-permeability magnetic materials on ceramic bobbin cores, possess ideal qualities for use in electronic computer assemblies as memory cells.

Specifically, their desirable properties include quite rectangular hysteresis loops, relatively low coercive values and high saturation densities; plus temperature stability and the ability to shift in a few microseconds from negative remanence to positive saturation, and vice versa, under conditions of pulse excitation.

Arnold Bobbin Cores are available in a wide range of sizes, tape thicknesses, widths and number of wraps to suit the ultimate use of the core. Magnetic materials usually employed are Deltamax, Square Permalloy and Supermalloy, in standard thicknesses of .001", .0005", .00025" and .000125". Special advantages derive from Arnold's position as a fully-integrated producer of wound cores, able to maintain precise control over every production operation . . . melting, rolling, winding, testing, etc.

● *Let us supply your requirements for bobbin cores or any other magnetic materials.*

W&D 5687

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

Los Angeles: 3450 Wilshire Blvd. Boston: 200 Berkeley St.

COMPUTERS AND AUTOMATION
Back Copies

ARTICLES, ETC.: JULY, 1955: Mathematics, the Schools, and the Oracle -- Alston S. Householder
The Application of Automatic Computing Equipment to Savings Bank Operations -- R. Hunt Brown
The Book Reviewer -- Rose Orente
Linear Programming and Computers, Part I -- Chandler Davis
August: The Automation of Bank Check Processing -- R. Hunt Brown
Linear Programming and Computers, Part II -- Chandler Davis
Justifying the Use of an Automatic Computer -- Ned Chapin
Charting on Automatic Data Processing Systems -- Harry Eisenpress, James L. McPherson, and Julius Shiskin
A Rotating Reading Head for Magnetic Tape and Wire -- National Bureau of Standards
Some Curiosities of Binary Arithmetic Useful in Testing Binary Computers -- Andrew D. Booth
September: A Big Inventory Problem and the IBM 702 -- Neil Macdonald
Publications for Business on Automatic Computers: A Basic Listing -- Ned Chapin
Franchise -- Isaac Asimov
Automatic Coding for Digital Computers -- G. M. Hopper
Automatic Programming: The A 2 Compiler System -- Part 1
October: The Brain and Learned Behavior -- Dr. Harry F. Harlow
Automatic Programming: The A 2 Compiler System -- Part 2
Who Are Manning the New Computers? -- John M. Breen

REFERENCE INFORMATION (in various issues):

Roster of Organizations in the Computer Field / Roster of Automatic Computing Services / Roster of Magazines Related to Computers and Automation / Automatic Computers: List / Automatic Computers: Estimated Commercial Population / Automatic Computing Machinery: List of Types / Components of Automatic Computing Machinery: List of Types / Products and Services in the Computer Field / Who's Who in the Computer Field / Automation: List of Outstanding Examples / Books and Other Publications / Glossary / Patents

BACK COPIES: Price, if available, $1.25 each, except June, 1955, $6.00. Vol. 1, no. 1, Sept. 1951, to vol. 1, no. 3, July, 1952: out of print. Vol. 1, no. 4, Oct. 1952: in print. Vol. 2, no. 1, Jan. 1953, to vol. 2, no. 9, Dec. 1953: in print except March, no. 2, and May, no. 4. Vol. 3, no. 1, Jan. 1954, to vol. 3, no. 10, Dec. 1954: in print. Vol. 4, 1955: in print.

A subscription (see rates on page 4) may be specified to begin with the current month's or the preceding month's issue.

WRITE TO:

Berkeley Enterprises, Inc.
Publisher of COMPUTERS AND AUTOMATION
36 West 11 St., New York 11, N. Y.

Mathematical Analyst Keith Kersery loads jet transport flutter problem into one of Lockheed's two 701's. On order: two 704's to help keep Lockheed in forefront of numerical analysis and production control data processing.

704's and 701's speed Lockheed research in numerical analysis

With two 701 digital computers already in operation, Lockheed has ordered two 704's to permit greater application of numerical analysis to complex aeronautical problems now being approached. Scheduled for delivery early next year, the 704's will replace the 701's.

Much of the work scheduled or in progress is classified. However, two significant features are significant to career-minded Mathematical Analysts: 1) the wide variety of assignments created by Lockheed's diversified development program and 2) the advanced nature of the work, which falls largely into unexplored areas of numerical analysis.

Career positions for Mathematical Analysts

Lockheed's expanding development program in nuclear energy, turbo-prop and jet transports, radar search planes, extremely high-speed aircraft and other classified projects has created a number of openings for Mathematical Analysts to work on the 704's.

Lockheed offers you attractive salaries, generous travel and moving allowances which enable you and your family to move to Southern California at virtually no expense; and an extremely wide range of employe benefits which add approximately 14% to each engineer's salary in the form of insurance, retirement pension, etc.

Those interested in advanced work in this field are invited to write E. W. Des Lauriers, Dept. MA-31-10.

LOCKHEED AIRCRAFT CORPORATION • CALIFORNIA DIVISION

BURBANK **CALIFORNIA**

ADVERTISING IN "COMPUTERS AND AUTOMATION"

Memorandum from Berkeley Enterprises, Inc.
Publisher of COMPUTERS AND AUTOMATION
36 West 11 St., New York 11, N.Y.

1. What is "COMPUTERS AND AUTOMATION"? It is a monthly magazine containing articles, papers, and reference information related to computing machinery, robots, automatic control, cybernetics, automation, etc. One important piece of reference information published is the "Roster of Organizations in the Field of Computers and Automation". The basic subscription rate is $4.50 a year in the United States. Single copies are $1.25, except June, 1955, "The Computer Directory" (164 pages, $6.00). For the titles of articles and papers in recent issues of the magazine, see the "Back Copies" page in this issue.

2. What is the circulation? The circulation includes 1900 subscribers (as of Sept. 10): over 300 purchasers of individual back copies; and an estimated 2500 nonsubscribing readers. The logical readers of COMPUTERS AND AUTOMATION are people concerned with the field of computers and automation. These include a great number of people who will make recommendations to their organizations about purchasing computing machinery, similar machinery, and components, and whose decisions may involve very substantial figures. The print order for the Nov. issue was 2400 copies. The overrun is largely held for eventual sale as back copies, and in the case of several issues the overrun has been exhausted through such sale.

3. What type of advertising does COMPUTERS AND AUTOMATION take? The purpose of the magazine is to be factual and to the point. For this purpose the kind of advertising wanted is the kind that answers questions factually. We recommend for the audience that we reach, that advertising be factual, useful, interesting, understandable, and new from issue to issue.

4. What are the specifications and cost of advertising? COMPUTERS AND AUTOMATION is published on pages 8½" x 11" (ad size, 7" x 10") and produced by photooffset, except that printed sheet advertising may be inserted and bound in with the magazine in most cases. The closing date for any issue is approximately the 10th of the month preceding. If possible, the company advertising should produce final copy. For photooffset, the copy should be exactly as desired, actual size, and assembled, and may include typing, writing, line drawing, printing, screened half tones, and any other copy that may be put under the photooffset camera without further preparation. Unscreened photographic prints and any other copy requiring additional preparation for photooffset should be furnished separately; it will be prepared, finished, and charged to the advertiser at small additional costs. In the case of printed inserts, a sufficient quantity for the issue should be shipped to our printer, address on request.

Display advertising is sold in units of full pages (ad size 7" x 10", basic rate, $170) and half pages (basic rate, $90); back cover, $330; inside front or back cover, $210. Extra for color red (full pages only and only in certain positions), 35%. Two-page printed insert (one sheet), $290; four-page printed insert (two sheets), $530. Classified advertising is sold by the word (50 cents a word) with a minimum of 20 words. We reserve the right not to accept advertising that does not meet our standards.

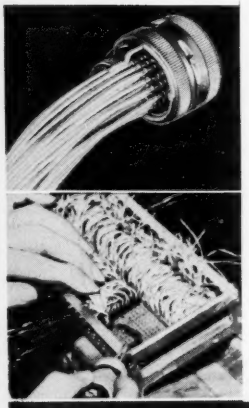
It is expected that there will be a rate change effective Dec. 1, approximately 10% increase.

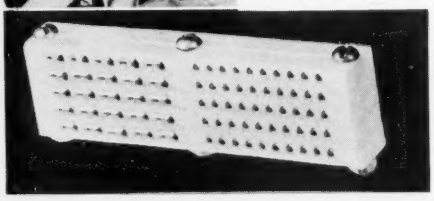
5. Who are our advertisers? Our advertisers in recent issues have included the following companies, among others:

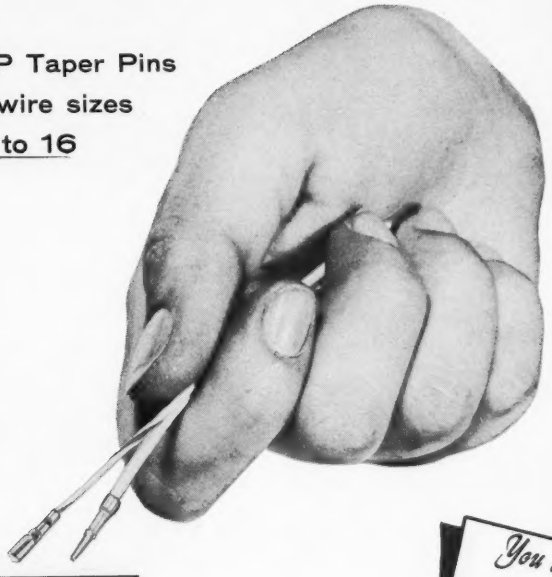
The Austin Co.
Automatic Electric Co.
Cambridge Thermionic Corp.
Federal Telephone and Radio Co.
Ferranti Electric Co.
Ferroxcube Corp. of America
General Electric Co.
Hughes Research and Development Lab.
International Business Machines Corp.
Lockheed Aircraft Corp.
Logistics Research, Inc.
Monrobot Corp.
Norden-Ketay Corp.
George A. Philbrick Researches, Inc.
Potter Instrument Co.
Raytheon Mfg. Co.
Reeves Instrument Co.
Remington Rand, Inc.
Sprague Electric Co
Sylvania Electric Products, Inc.

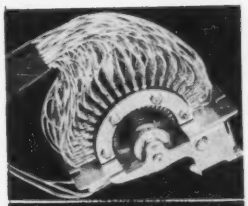
AMP Taper Tab
receptacles for wire
sizes 26 to 18

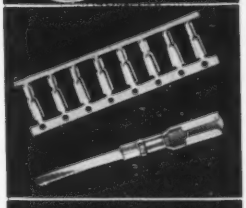
AMP Taper Pins
for wire sizes
26 to 16

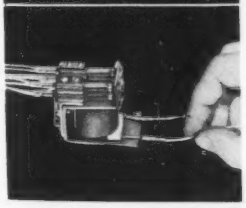












You are cordially invited to visit the AMP booth at the I. R. E. show.
Booths 770 and 772

less cube and cost

WITH ADDED RELIABILITY

Cubic restrictions have brought about a whole new concept of wire termination. The AMP Taper Technique with AMP taper pins, tab receptacles, blocks and modified miniature components will help you take full advantage of small wire, small insulation and small space for your wire terminations.

Another example of AMP's Creative Approach to Better Wiring

AMP

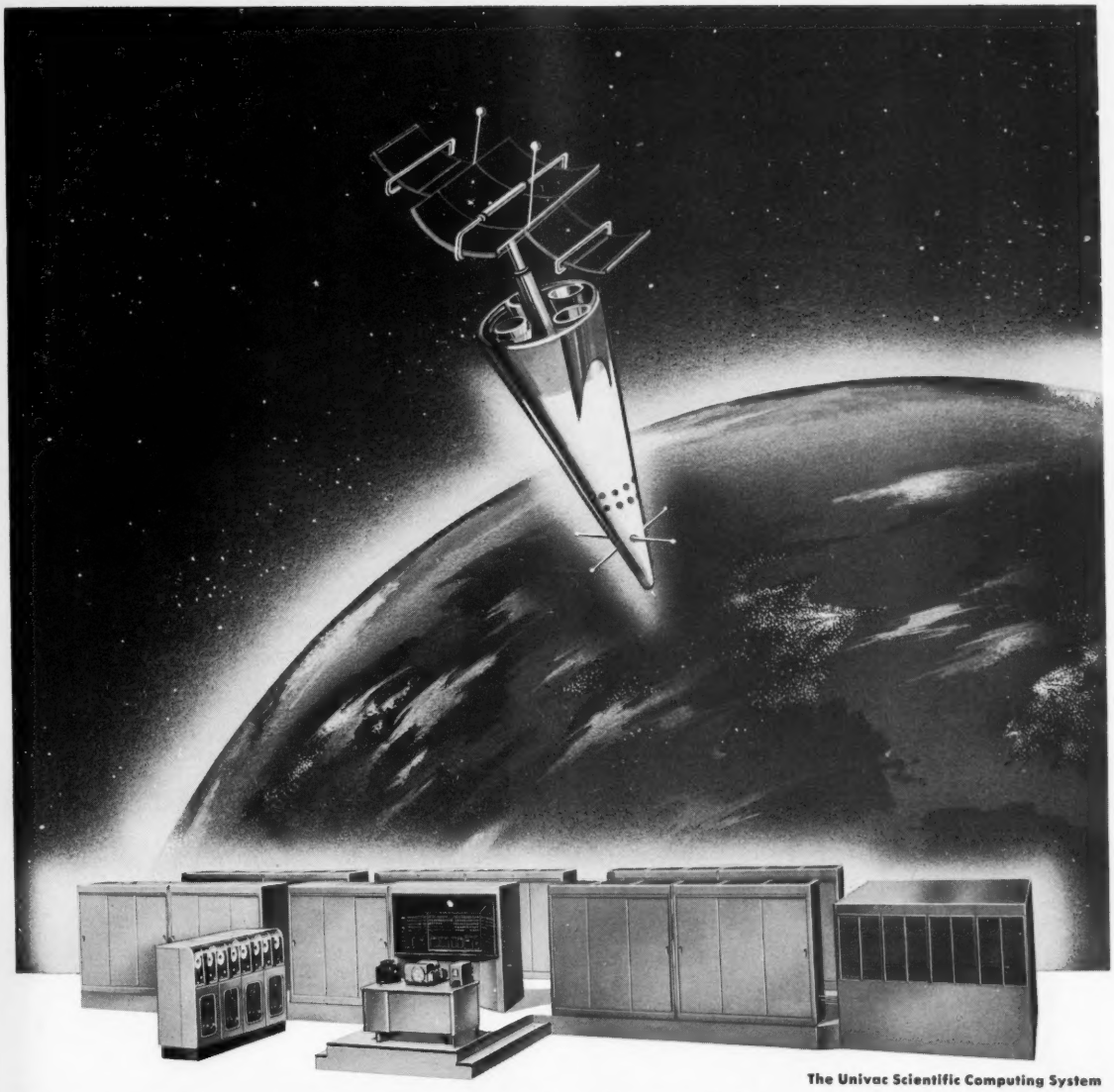
Send today for your copy of our brochure, AMP's Creative Approach to Better Wiring.

AIRCRAFT-MARINE PRODUCTS, INC., 2100 Paxton Street, Harrisburg, Pa.
In Canada: AIRCRAFT-MARINE PRODUCTS OF CANADA, LTD., 1764 Avenue Road, Toronto 12, Ontario, Canada

ADVERTISING INDEX

The purpose of COMPUTERS AND AUTOMATION is to be factual, useful, and understandable. For this purpose, the kind of advertising we desire to publish is the kind that answers questions, such as: What are your products? What are your services? And for each product: What is it called? What does it do? How well does it work? What are its main specifications? We reserve the right not to accept advertising that does not meet our standards.

Following is the index and a summary of advertisements. Each item contains: Name and address of the advertiser / subject of the advertisement / page number where it appears.



The Univac Scientific Computing System

Launching Tomorrow's Satellite

When the first man-made satellite is launched on its orbit around the earth, it will owe its existence to the thousands of missiles which have preceded it, and to the careful analysis of their patterns of flight. The Univac Scientific of Remington Rand has speeded this effort immeasurably, handling flight analyses for the nation's guided missile program.

Each missile firing, each analysis, involves enormous amounts of in-flight data, with manual computations normally requiring from 250 to 500 hours. This staggering work load is accomplished by the Univac Scientific Electronic Computer in approximately *4 to 8 minutes.*

Because of its ability to reduce large volumes of data at tremendous speeds, the Univac Scientific System easily handles even the most difficult research problems. Its speed is matched by many other outstanding characteristics, including: superb operating efficiency, obtained through large storage capacity . . . great programming versatility . . . the ability to operate simultaneously with a wide variety of input-output devices . . . and far greater reliability than any computer of its type.

For more information about the Univac Scientific System or for information about how you might apply the system to your particular problems, write on your business letterhead to . . .

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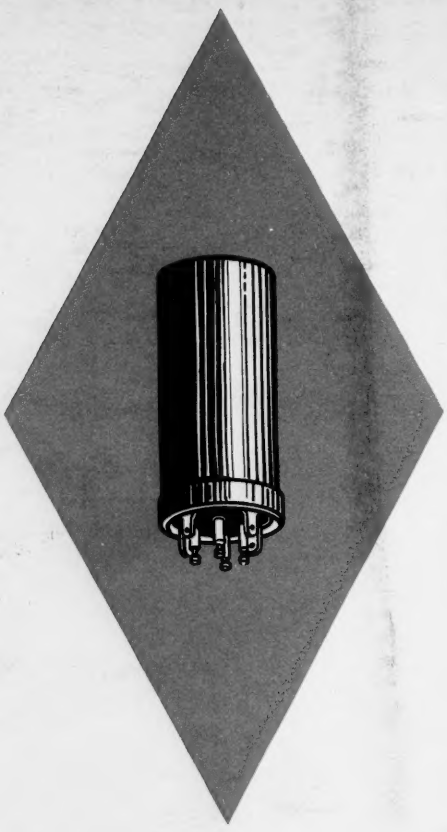

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